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TECHNICAL INFORMATION BULLETIN 80-5

REVISED CCITT RECOMMENDATION X.25 1980

Harold C. Folts

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This report contains the final draft of CCITT Recommendation X.25 as approved February 1980. X.25 defines the interface procedures for connection of user terminals to Public Packet-Switched Data Networks. The report also provides the background and a summary of the revisions made for this new version of X.25.

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TECHNICAL INFORMATION BULLETIN 80-5

REVISED CCITT RECOMMENDATION X.25, 1980

AUGUST 1980

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FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program which is an element of the overall GSA Federal Standardization Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee, identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the Electronic Industries Association, the American National Standards Institute, the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of data communication interface standards. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs, or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

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BACKGROUND

Intense activity over the past several years is leading to a new generation of interface standards for the emerging public data networks being implemented in numerous countries around the world. These new data networks will offer a variety of services including circuit-switched, packet-switched, and leased line to support the rapidly expanding computer and digital communications requirements.

Packet-switching technology is presently dominating current implementations as exemplified by Telenet and Tymnet in the USA. Active implementations are also underway in Canada, Japan, and many European countries.

The International Telegraph and Telephone Consultative Committee (CCITT) has lead the way in early standardization of interface protocols to encourage timely implementations on a worldwide basis. In early 1976, the draft proposal was introduced into CCITT for a virtual circuit packet-switched service. Agreement was reached in May 1976, and in September 1976, the proposal was approved as Recommendation X.25 by the CCITT Sixth Plenary Assembly.

The unprecedented speed at which X.25 was adopted left serious questions as to the technical soundness of the standard. There were many uncompleted items left "for further study," and there were numerous ambiguities. The fact that international agreement was received, however, was sufficient for a number of technologically advanced countries to make large investments in implementing new public data networks using this packet-switching technology. As a result, the 1976 version X.25 proved to be an effective guideline for the new generation of designs.

X.25 describes the interface and procedures for packet-switched service and is defined in three independent architectural levels as follows:

- Level 1 - The physical, electrical, functional, and procedural characteristics to activate, maintain, and deactivate the physical link between the DTE and the DCE.
- Level 2 - The link access procedure for data interchange across the link between the DTE and the DCE.
- Level 3 - The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and DCE.

Two types of virtual circuit operation were originally specified. The first is virtual call service which establishes and end-to-end connection through the packet network. This connection is held for the duration of the communication, then released. The other is permanent virtual circuit service which is a continuous connection between two users through a packet network. These two services effectively simulate dialed circuit-switched connections and leased circuits, respectively.

Since the approval of X.25, intense work has continued to expand, enhance, and complete the basic Recommendation for approval at the CCITT Seventh Plenary Assembly in November of 1980. This new version of X.25 will be a sound, established standard rather than a design guideline as it was initially. The appendix of this TIB contains the complete text of the revised X.25 which is to be presented for approval at the November 1980 Plenary where no further technical change is expected.

Work is now proceding to adopt X.25 (1980) as a joint Federal Telecommunications Standard (FED-STD)-1041) for Telecommunication Applications and Federal Information Processing Standard (FIPS) for ADP applications. Publication is expected to be in mid 1981. In the meantime due to a large demand the application of X.25 by Federal agencies, consideration is being given to early publication of an Interim Federal Standard 1041 in November 1980 for optional use.

SUMMARY OF REVISIONS

Physical Level - The text was greatly clarified to specify two means of access - dedicated circuit and switched circuit. The operating conditions applicable for X.21 and X.21 bis are more fully described to include the interface signal conditions and the provision for failure detection and fault isolation.

Link Level - Significant changes have been made since the original 1976 version. In 1978 a provisional revision was issued specifying a new procedure known as LAP-B to achieve compatibility with the ISO HDLC standards. Subsequently LAP-B was further refined and is now identified as the preferred procedure and will be available in all networks. This is compatible with the HDLC BA class of procedures with options 2 and 8 (ANSI X3.66 ADCCP BA Class, options 2, 8, and 11).

Packet Level - A number of significant techical and editorial enhancements were made for this level. Many technical ambiguities were eliminated and coding of the many fields were expanded and completed.

More importantly, the provisions for Datagram service were added. The datagram operation has been one of considerable controversy in CCITT. Determined efforts from the USA, however, have now resulted in general acceptance. Datagrams are self-contained packets with a maximum of 128 octets of user data, and each datagram has sufficient address information to be routed to its destinations. No call set-up procedures are necessary. Datagram operations more efficient for fast transport of small units of data and provides greater flexibility for a number of network and user applications. At this time, however, ther are no known public data network implementating of Datagram Service.

Additionaly, a fast select facility was added to virtual call service. The Fast Select provision allows a full 128 octets of user data to be exchanged during the call set-up and clearing procedures for a virtual call. Fast Select also greatly increases the efficiency of operation for many transaction applications and will be implemented by many public data networks for this purpose.

To resolve a serious incompatibility among some of the early X.25 implementations, a new procedure was added to dynamically select, on a per data packet basis whether acknowledgment of receipt should have local significance or end-to-end sigificance. The 7^{th} bit of the first octet of data packets was designated as the D bit for delivery confirmation. If D=0, the packet is only acknowledged by the first mode of the network. When D=1, the packet is not acknowledged until it is received and acknowledged by the destination DTE.

Additional enhancements of particular note include the following:

a. Standard values which apply to all implementations were established a maximum data field size of 12 octets, a window size of 2, and packet sequence numbering of module 8. Other values may be use in addition as options either by subscription or on a per call basis.

b. The assignment of logical channels is standardized.

c. The number of optional user facilities has been expanded from 5 to 29. More detailed description of their operation has also been included.

d. Bits 7 and 8 of the first octet of the Call User Data field of call set-up packet have been standardized to indicate possible higher level protocols.

e. The state diagrams and DCE action tables have been reorganized and enhanced for better clarity and for competeness.

f. The signals and encoding of the diagnostic fields were added.

g. An optional DCE diagnostic packet was added to assist recovery from some error conditions.

h. Logical channel 0 was reserved for Restart and Diagnostic packets only.

i. DCE time-outs and DTE time-limits were added for determing error conditions.

It was agreed by the administrations in CCITT that all networks would implement the new provisions of the 1980 version of X.25 by January 1982. Although there were some significant diferences in early (pre 1980) implementations due to ambiguities and incomplete specifications, X.25 has now envolved to be a reasonably complete and sound standard that has gained significant world-wide acceptance.

NCS TIB 80-5

APPENDIX

DRAFT

OF

REVISED

CCITT RECOMMENDATION X.25
(1980)

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE ON PUBLIC DATA NETWORKS

The establishment in various countries of public data networks providing packet-switching data transmission services creates a need to produce standards to facilitate international interworking.

The CCITT,

considering

a) that Recommendation X.1 includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 defines user facilities, Recommendations X.21 and X.21 *bis* define DTE/DCE physical level interface characteristics, Recommendation X.92 defines the logical control links for packet-switching data transmission services and Recommendation X.96 defines call progress signals;

b) that data terminal equipments operating in the packet mode will send and receive network control information in the form of packets;

c) that certain data terminal equipments operating in the packet mode will use a packet interleaved synchronous data circuit;

d) the desirability of being able to use a single data circuit to a DSE for all user facilities;

e) that Recommendation X.2 designates virtual call and permanent virtual circuit services as essential (E) services to be provided by all networks and designates datagram service as an additional (A) service which may be provided by some networks;

f) the need for defining an international recommendation for the exchange between DTE and DCE of control information for the use of packet-switching data transmission services;

g) that the necessary elements for an interface recommendation should be defined independently as:

Physical Level - The mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link between the DTE and the DCE.

Link Level - The link access procedure for data interchange across the link between the DTE and the DCE.

Packet Level - The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE.

(unanimously) declares the view

that for data terminal equipments operating in the packet mode:

1. The mechanical, electrical, functional and procedural characteristics to activate, maintain, and deactivate the physical link between the DTE and the DCE should be as specified in 1 below, *DTE/DCE interface characteristics.*

2. The link access procedure for data interchange across the link between the DTE and the DCE should be as specified in 2 below, *Link access procedure across the DTE/DCE interface.*

3. The packet level procedures for the exchange of control information and user data at the DTE/DCE interface should be as specified in 3 below, *Description of the packet level DTE/DCE interface.*

4. The procedures for virtual call and permanent virtual circuit services should be as specified in 4 below, *Procedures for virtual circuit services.*

5. The procedures for datagram service should be as specified in 5. below *Procedures for datagram service.*

6. The format for packets exchanged between the DTE and the DCE should be as specified in 6 below, *Packet formats.*

7. Procedures and formats for optional user facilities should be as specified in 7 below, *Procedures and formats for optional user facilities.*

CONTENTS

1. DTE/DCE INTERFACE CHARACTERISTICS (PHYSICAL LEVEL)

The DTE/DCE physical interface characteristics defined as the Physical Level element shall be in accordance with Recommendation X.21. For an interim period, some Administrations or RPOAs may offer a DTE/DCE interface at this level in accordance with Recommendation X.21 bis. The exact use of the relevant sections is detailed below.

1.1 The Interface Characteristics for a DTE Connected to a Packet Switched Data Transmission Service by a Dedicated Circuit

1.1.1 X.21

1.1.1.1 The DTE/DCE physical interface elements shall be according to section 2 of Recommendation X.21.

1.1.1.2 The operation of test loops shall be according to section 7 of Recommendation X.21.

1.1.1.3 The procedures for entering operational phases shall be as follows:

a) When the DTE signals c = ON, signals on circuit T shall be according to the higher level procedures described in the following sections of this Recommendation.

b) When the DCE signals i = ON, signals on circuit R shall be according to the higher level procedures described in the following sections of this Recommendation.

c) The DTE/DCE interface should normally remain in the operational condition with both c = ON and i = ON to enable proper operation of the higher level procedures described in the following sections of this Recommendation.

d) If a situation necessitates the DTE to signal DTE ready or DTE uncontrolled not ready, or the DCE to signal DCE ready or DCE not ready, the interface should return to the operational condition with both c = ON and i = ON when the situation is appropriate to enable normal operation of higher level procedures described in the following sections of this Recommendation.

1.1.2 X.21 bis

1.1.2.1 The DTE/DCE physical interface elements shall be according to section 1 of Recommendation X.21 bis.

1.1.2.2 Failure detection and fault isolation shall be according to section 3 of Recommendation X.21 bis.

1.1.2.3 When circuits 105, 106, 107, 108 and 109 are in the ON condition, signals on circuits 103 and 104 shall be according to the higher level procedures described in the following sections of this Recommendation.

1.2 <u>The Interface Characteristics and Procedures for a DTE Connected to a Packet Switched Data Transmission Service through a Circuit Switched Data Transmission Service</u>

<u>Note</u>: The full interworking regarding the user facilities and architectural aspects of the following interface characteristics and procedures are a subject of further study.

1.2.1 <u>X.21</u>

1.2.1.1 The DTE/DCE physical interface elements shall be according to section 2 of Recommendation X.21. The procedures for circuit switched access shall be according to sections 3, 4, 5.1 and 6 of Recommendation X.21.

1.2.1.2 The operation of test loops shall be according to section 7 of Recommendation X.21.

1.2.1.3 When c = ON and i = ON (X.21 state 12 or 13), signals on circuits T and R shall be according to the higher level procedures described in the following sections of this Recommendation.

1.2.2 <u>X.21 bis</u>

1.2.2.1 The DTE/DCE physical interface elements and call establishment procedures shall be according to section 2 of Recommendation X.21 bis.

1.2.2.2 Failure detection and fault isolation shall be according to section 3 of Recommendation X.21 bis.

1.2.2.3 When circuits 105, 106, 107, 108 and 109 are in the ON condition, signals on circuits 103 and 104 shall be according to the higher level procedures described in the following sections of this Recommendation.

2. LINK ACCESS PROCEDURE ACROSS THE DTE/DCE INTERFACE

2.1 Scope and Field of Application

2.1.1 The link access procedures (LAP and LAPB) are described as the Link Level elements and are used for data interchange between a DCE and a DTE operating in user classes of service 8 to 11 as indicated in Recommendation X.1.

2.1.2 The procedures use the principle and terminology of the High Level Data Link Control (HDLC) procedure specified by the International Organization for Standardization (ISO).

2.1.3 The transmission facility is duplex.

2.1.4 DCE compatibility of operation with the ISO balanced class of procedure (Class BA, options 2,8) is achieved using the provisions found under the headings annotated as "applicable to LAPB" in this Recommendation.

DTE manufacturers and implementors must be aware that the procedure hereunder described as LAPB will be the only one available in all networks.

Likewise, a DTE may continue to use the provisions found under the heading annotated as "applicable to LAP" in this Recommendation (in those networks supporting such a procedure), but for new DTE implementations, LAPB should be preferred.

Note: Other possible applications for further study are, for example:

- two-way alternate, asynchronous response mode
- two-way simultaneous, normal response mode
- two-way alternate, normal response mode

2.2 Frame Structure

2.2.1 All transmissions are in frames conforming to one of the formats of Table 2.1/X.25. The flag preceding the address field is defined as the opening flag.

TABLE 2.1/X.25 - Frame formats

Bit order of transmission	12345678	12345678	12345678	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	FCS 16-bits	F 01111110

FCS=frame checking sequence

Bit order of transmission	12345678	12345678	12345678		16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	I N-bits	FCS 16-bits	F 01111110

FCS=frame checking sequence

2.2.2 Flag Sequence

All frames shall start and end with the flag sequence consisting of one 0 followed by six contiguous 1s and one 0. A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

2.2.3 Address Field

The address field shall consist of one octet. The coding of the address field is described in 2.4.2 below.

2.2.4 Control Field

The control field shall consist of one octet. The content of this field is described in 2.3.2 below.

Note: The use of the extended control field is a subject for further study.

2.2.5 Information Field

The information field of a frame is unrestricted with respect to code or grouping of bits except for the packet formats specified in 3 below.

See 2.3.4.10 and 2.4.11.3 below with regard to the maximum information field length.

2.2.6 Transparency

The DTE or DCE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS sequences and shall insert a 0 bit after all sequences of 5 contiguous 1 bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated. The DTE or DCE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows 5 contiguous 1 bits.

2.2.7 Frame Checking Sequence (FCS)

The FCS shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

1. The remainder of $x^k(x^{15} + x^{14} + x^{13} + \ldots + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and

2. the remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the content of the frame, existing between but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at the transmitter, the initial remainder of the division is preset to all ones and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16 bit FCS sequence.

At the receiver, the initial remainder is preset to all ones, and the serial incoming protected bits and the FCS when divided by the generator polynomial will result in a remainder of 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

2.2.8 Order of Bit Transmission

Addresses, commands, responses and sequence numbers shall be transmitted with the low order bit first (for example the first bit of the sequence number that is transmitted shall have the weight 2^0).

The order of transmitting bits within the information field is not specified under 2 of this Recommendation. The FCS shall be transmitted to the line commencing with the coefficient of the highest term.

Note: The low order bit is defined as bit 1, as depicted in Tables 2.1/X.25 to 2.4/X.25.

2.2.9 Invalid Frames

A frame not properly bounded by two flags, or having fewer than 32 bits between flags, is an invalid frame.

2.2.10 Frame Abortion

Aborting a frame is performed by transmitting at least seven contiguous 1s (with no inserted 0s).

2.2.11 Interframe Time Fill

Interframe time fill is accomplished by transmitting contiguous flags between frames.

2.2.12 Link Channel States

2.2.12.1 Active Channel State

A channel is in an active condition when the DTE or DCE is actively transmitting a frame, an abortion sequence or interframe time fill.

2.2.12.2 Idle Channel State

A channel is defined to be in an idle condition when a contiguous 1s state is detected that persists for at least 15 bit times.

Note 1: The action to be taken upon detection of the idle channel state is a subject for further study.

Note 2: A link channel as defined here is the means of transmission for one direction.

2.3 Elements of Procedure

2.3.1 The elements of procedure are defined in terms of actions that occur on receipt of commands at a DTE or DCE.

The elements of procedure specified below contain a selection of commands and responses relevant to the link and system configuration described in 2.1 above.

A procedure is derived from these elements of procedure and is described in 2.4 below. Together 2.2 and 2.3 form the general requirements for the proper management of the access link.

2.3.2 Control Field Formats and State Variables

2.3.2.1 Control Field Formats

The control field contains a command or a response, and sequence numbers where applicable.

Three types of control field formats (see Table 2.2/X.25) are used to perform numbered information transfer (I frames), numbered supervisory functions (S frames) and unnumbered control functions (U frames).

TABLE 2.2/X.25 - Control field formats

Control field bits	1	2	3	4	5	6	7	8
I frame	0	N(S)			P/F	N(R)		
S frame	1	0	S	S	P/F	N(R)		
U frame	1	1	M	M	P/F	M	M	M

N(S) = transmitter send sequence number (bit 2 = low order bit)
N(R) = transmitter receive sequence number (bit 6 = low order bit)
S = supervisory function bit
M = modifier function bit
P/F = poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final)

Information transfer format - I

The I format is used to perform an information transfer. The functions of N(S), N(R) and P/F are independent; i.e., each I frame has an N(S), an N(R) which may or may not acknowledge additional frames received by the DTE or DCE, and a P/F bit.

Supervisory format - S

The S format is used to perform link supervisory control functions such as acknowledge I frames, request retransmission of I frames, and to request a temporary suspension of transmission of I frames.

Unnumbered format - U

The U format is used to provide additional link control functions. This format contains no sequence numbers. The encoding of the unnumbered commands is as defined in Table 2.3/X.25.

2.3.2.2 Control Field Parameters

The various parameters associated with the control field formats are described below.

2.3.2.3 Modulus

Each I frame is sequentially numbered and may have the value 0 through modulus minus one (where "modulus" is the modulus of the sequence numbers). The modulus equals 8 and the sequence numbers cycle through the entire range.

2.3.2.4 Frame Variables and Sequence Numbers

2.3.2.4.1 Send State Variable V(S)

The send state variable denotes the sequence number of the next in-sequence I frame to be transmitted. The send state variable can take on the value 0 through modulus minus one. The value of the send state variable is incremented by one with each successive I frame transmission, but at the DCE cannot exceed N(R) of the last received I or S frame by more than the maximum number of outstanding I frames (k). The value of k is defined in 2.4.11.4 below.

2.3.2.4.2 Send Sequence Number N(S)

Only I frames contain N(S), the send sequence number of transmitted frames. Prior to transmission of an in-sequence I frame, the value of N(S) is updated to equal the value of the send state variable.

2.3.2.4.3 Receive State Variable V(R)

The receive state variable denotes the sequence number of the next in-sequence I frame to be received. This receive state variable can take on the values 0 through modulus minus one. The value of the receive state variable is incremented by the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable.

2.3.2.4.4 Receive Sequence Number N(R)

All I frames and S frames contain N(R), the expected sequence number of the next received I frame. Prior to transmission of a frame of the above types, the value of N(R) is updated to equal the current value of the receive state variable. N(R) indicates that the DTE or DCE transmitting the N(R) has correctly received all I frames numbered up to and including N(R) - 1.

2.3.3 Functions of the Poll/Final Bit

The poll/final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit.

The use of the P/F bit is described in 2.4.3 below.

2.3.4 Commands and Responses

The following commands and responses will be used by either the DTE or DCE and are represented in Table 2.3/X.25.

TABLE 2.3/X.25 - Commands and responses

Format	Commands	Responses	Encoding							
			1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SARM (set asynchronous response mode)	DM (disconnected mode)	1	1	1	1	P/F	0	0	0
	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC (disconnect)		1	1	0	0	P	0	1	0
		UA (unnumbered acknowledgement)	1	1	0	0	F	1	1	0
		CMDR (command reject) FRMR (frame reject)	1	1	1	0	F	0	0	1

Note 1: The need for, and use of, additional commands and responses are for further study.

Note 2: DTEs do not have to implement both SARM and SABM; furthermore DM and SABM need not be used if SARM only is used.

Note 3: RR, RNR and REJ supervisory command frames are not used by the DCE when SARM is used (LAP).

The commands and responses are as follows:

2.3.4.1 Information (I) Command

The function of the information (I) command is to transfer across a data link sequentially numbered frames containing an information field.

2.3.4.2 Receive Ready (RR) Command and Response

The receive ready (RR) supervisory frame is used by the DTE or DCE to:

1) indicate it is ready to receive an I frame;

2) acknowledge previously received I frames numbered up to and including N(R) - 1.

RR may be used to clear a busy condition that was initiated by the transmission of RNR. The RR command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE, or DTE, respectively.

2.3.4.3 Reject (REJ) Command and Response

The reject (REJ) supervisory frame is used by the DTE or DCE to request retransmission of I frames starting with the frame numbered N(R). I frames numbered N(R) - 1 and below are acknowledged. Additional I frames pending initial transmission may be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ. The REJ command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE or DTE, respectively.

2.3.4.4 Receive Not Ready (RNR) Command and Response

The receive not ready (RNR) supervisory frame is used by the DTE or DCE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I frames numbered up to and including N(R) - 1 are acknowledged. I frame N(R) and subsequent I frames received, if any, are not acknowledged; the acceptance status of these I frames will be indicated in subsequent exchanges.

An indication that the busy condition has cleared is communicated by the transmission of a UA, RR, REJ or SABM. The RNR command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE or DTE, respectively.

2.3.4.5 Set Asynchronous Response Mode (SARM) Command

The SARM unnumbered command is used to place the addressed DTE or DCE in the asynchronous response mode (ARM) information transfer phase.

No information field is permitted with the SARM command. A DTE or DCE confirms acceptance of SARM by the transmission at the first opportunity of a UA response. Upon acceptance of this command the DTE or DCE receive state variable V(R) is set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.6 Set Asynchronous Balanced Mode (SABM) Command

The SABM unnumbered command is used to place the addressed DTE or DCE in the asynchronous balanced mode (ABM) information transfer phase.

No information field is permitted with the SABM command. A DTE or DCE confirms acceptance of SABM by the transmission at the first opportunity of a UA response. Upon acceptance of this command the DTE or DCE send state variable V(S) and receive state variable V(R) are set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.7 Disconnect (DISC) Command

The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the DTE or DCE receiving the DISC that the DTE or DCE sending the DISC is suspending operation. No information field is permitted with the DISC command. Prior to actioning the command, the DTE or DCE receiving the DISC confirms the acceptance of DISC by the transmission of a UA response. The DTE or DCE sending the DISC enters the disconnected phase when it receives the acknowledging UA response.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.8 Unnumbered Acknowledge (UA) Response

The UA unnumbered response is used by the DTE or DCE to acknowledge the receipt and acceptance of the U format commands. Received U format commands are not actioned until the UA response is transmitted. The UA response is transmitted as directed by the received U format command. No information field is permitted with the UA response.

2.3.4.9 Disconnected Mode (DM) Response

The DM response is used to report a status where the DTE or DCE is logically disconnected from the link, and is in the disconnected phase. The DM response is sent in this phase to request a set mode command, or, if sent in response to the reception of a set mode command, to inform the DTE or DCE that the DCE or DTE, respectively, is still in disconnected phase and cannot action the set mode command. No information field is permitted with the DM response.

A DTE or DCE in a disconnected phase will monitor received commands, and will react to SABM as outlined in 2.4.5 below and will respond DM to any other command received with the P bit set to 1.

2.3.4.10 Command Reject (CMDR) Response
Frame Reject (FRMR) Response

The CMDR (FRMR) response is used by the DTE or DCE to report an error condition not recoverable by retransmission of the identical frame; i.e., one of the following conditions, which results from the receipt of a frame without FCS error:

1. the receipt of a command or response that is invalid or not implemented;

2. the receipt of an I frame with an information field which exceeds the maximum established length;

3. the receipt of an invalid N(R). (In the case of LAP, see 2.4.8.1)

4. the receipt of a frame with an information field which is not permitted or the receipt of an S or U frame with incorrect length.

An invalid N(R) is defined as one which points to an I frame which has previously been transmitted and acknowledged or to an I frame which has not been transmitted and is not the next sequential I frame pending transmission.

An information field which immediately follows the control field, and consists of 3 octets, is returned with this response and provides the reason for the CMDR (FRMR) response. This format is given in Table 2.4/X.25.

TABLE 2.4/X.25 - CMDR (FRMR) information field format

Information field bits

1 2 3 4 5 6 7 8	9	10 11 12	13	14 15 16	17	18	19	20	21	22	23	24
Rejected frame control field	0	V(S)	see Note	V(R)	W	X	Y	Z	0	0	0	0

- Rejected frame control field is the control field of the received frame which caused the command (frame) reject.

- V(S) is the current send state variable value at the DTE or DCE reporting the rejection condition (bit 10 = low order bit).

- V(R) is the current receive state variable value at the DTE or DCE reporting the rejection condition (bit 14 = low order bit).

- W set to 1 indicates that the control field received and returned in bits 1 through 8 was invalid or not implemented.

- X set to 1 indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted or is an S or U frame with incorrect length. Bit W must be set to 1 in conjunction with this bit.

- Y set to 1 indicates that the information field received exceeded the maximum established capacity of the DTE or DCE reporting the rejection condition.

- Z set to 1 indicates that the control field received and returned in bits 1 through 8 contained an invalid N(R).

<u>Note</u>: Bits 9, 13, 21 to 24 shall be set to 0 for CMDR. For FRMR, bits 9, 21 to 24 shall be set to 0. Bit 13 shall be set to 1 if the frame rejected was a response, and set to 0 if the frame rejected was a command.

2.3.5 Exception Condition Reporting and Recovery

The error recovery procedures which are available to effect recovery following the detection/occurrence of an exception condition at the link level are described below. Exception conditions described are those situations which may occur as the result of transmission errors, DTE or DCE malfunction or operational situations.

2.3.5.1 Busy Condition

The busy condition results when a DTE or DCE is temporarily unable to continue to receive I frames due to internal constraints, e.g., receive buffering limitations. In this case an RNR frame is transmitted from the busy DCE or DTE. I frames pending transmission may be transmitted from the busy DTE or DCE prior to or following the RNR. Clearing of the busy condition is indicated as described in 2.3.4.4 above.

2.3.5.2 N(S) Sequence Error

The information field of all I frames whose N(S) does not equal the receive state variable V(R) will be discarded.

An N(S) sequence exception condition occurs in the receiver when an I frame received error-free (no FCS error) contains an N(S) which is not equal to the receive state variable at the receiver. The receiver does not acknowledge (increment its receive state variable) the I frame causing the sequence error, or any I frame which may follow, until an I frame with the correct N(S) is received.

A DTE or DCE which receives one or more I frames having sequence errors but otherwise error-free shall accept the control information contained in the N(R) field and the P bit to perform link control functions; e.g., to receive acknowledgement of previously transmitted I frames and to cause the DTE or DCE to respond (P bit set to 1). Therefore, the retransmitted I frame may contain an N(R) field and P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frame.

2.3.5.3 REJ Recovery

The REJ is used to initiate an exception recovery (retransmission) following the detection of a sequence error.

Only one "sent REJ" exception condition from a DTE or DCE is established at a time. A sent REJ exception condition is cleared when the requested I frame is received.

A DTE or DCE receiving REJ initiates sequential (re-)transmission of I frames starting with the I frame indicated by the N(R)

obtained in the REJ frame.

2.3.5.4 Time-out Recovery

If a DTE or DCE, due to a transmission error, does not receive (or receives and discards) a single I frame or the last I frame in a sequence of I frames, it will not detect an out-of-sequence exception condition and therefore will not transmit REJ. The DTE or DCE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period (see 2.4.11.1 below), take appropriate recovery action to determine at which I frame retransmission must begin.

2.3.5.5 FCS Error and Invalid Frame

Any frame received with an FCS error or which is invalid (see 2.2.9 above) will be discarded and no action is taken as the result of that frame.

2.3.5.6 Rejection Condition

A rejection condition is established upon the receipt of an error free frame which contains an invalid command/response in the control field, an invalid frame format, an invalid N(R) (however see 2.4.8.1 below for LAP application) or an information field which exceeds the maximum information field length which can be accommodated.

At the DTE or DCE, this exception is reported by a CMDR (FRMR) response for appropriate DCE or DTE action, respectively. Once a DCE has established a CMDR (FRMR) exception, no additional I frames are accepted, until the condition is reset by the DTE, except for examination of the P bit (LAPB) or examination of the P bit and N(R) (LAP). The CMDR (FRMR) response may be repeated at each opportunity until recovery is effected by the DTE, or until the DCE initiates its own recovery.

2.4 Description of the Procedure

2.4.1 Procedure to Set the Mode Variable B (Applicable if Both LAP and LAPB are Implemented)

The DCE will maintain an internal mode variable B, which it will set as follows:

- to 1, upon acceptance of an SABM command from the DTE

- to 0, upon acceptance of an SARM command from the DTE.

Changes to the mode variable B by the DTE should occur only when the link has been disconnected as described in 2.4.4.3 or 2.4.5.3 below.

Should a DCE malfunction occur, the internal mode variable B will upon restoration of operation, but prior to link set-up by the DTE, be initially set to 1.

Whenever B is 1, the DCE will use the LAPB link set-up and disconnection procedure and is said to be in the LAPB (balanced) mode.

Whenever B is 0, the DCE will use the LAP link set-up and disconnection procedure, and is said to be in the LAP mode.

The following are applicable to both LAP and LAPB modes: 2.4.2, 2.4.3, 2.4.6, 2.4.11.

The following are applicable only to the LAP mode: 2.4.4, 2.4.7, 2.4.8.

The following are applicable only to the LAPB mode: 2.4.5, 2.4.9, 2.4.10.

2.4.2 Procedure for Addressing (Applicable to Both LAP and LAPB)

Frames containing commands transferred from the DCE to the DTE will contain the address A.

Frames containing responses transferred from the DTE to the DCE shall contain the address A.

Frames containing commands transferred from the DTE to the DCE shall contain the address B.

Frames containing responses transferred from the DCE to the DTE will contain the address B.

A and B addresses are coded as follows:

Address	1	2	3	4	5	6	7	8
A	1	1	0	0	0	0	0	0
B	1	0	0	0	0	0	0	0

Note: The DCE will discard all frames receive with an address other than A or B; the DTE should do the same.

2.4.3 Procedure for the Use of the P/F Bit (Applicable to Both LAP and LAPB)

The DTE or DCE receiving a SARM, SABM, DISC, supervisory command or an I frame with the P bit set to 1, will set the F bit to 1 in the next response frame it transmits.

The response frame returned by the DCE to a SARM, SABM or DISC command with the P bit set to 1 will be a UA (or DM) response with the F bit set to 1. The response frame returned by the DCE to an I frame with the P bit set to 1 will be an RR, REJ or RNR or CMDR or FRMR response format with the F bit set to 1.

The response frame returned by the DCE to a supervisory command frame with the P bit set to 1 will be an RR, RNR or CMDR or FRMR response with the F bit set to 1.

The P bit may be used by the DCE in conjunction with the timer recovery condition (see 2.4.6.8 below).

Note Other use of the P bit by the DCE is a subject for further study.

2.4.4 Procedure for Link Set-up and Disconnection (Applicable to LAP)

2.4.4.1 Link Set-up

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

The DTE shall indicate a request for setting up the link by transmitting a SARM command to the DCE.

Whenever receiving a SARM command, the DCE will return a UA response to the DTE and set its receive state variable V(R) to 0.

Should the DCE wish to indicate a request for setting up the link, or after transmission of a UA response to a first SARM command from the DTE as a request for setting up the link, the DCE will transmit a SARM command to the DTE and start Timer T1 (see 2.4.11.1 below). The DTE will confirm the reception of the SARM command by transmitting a UA response.

When receiving the UA response the DCE will set its send state variable to 0 and stop its Timer T1. If Timer T1 runs out before the UA response is received by the DCE, the DCE will retransmit a SARM command and restart Timer T1.

After transmission of SARM N2 times by the DCE, appropriate recovery action will be initiated.

The value of N2 is defined in 2.4.11.2 below.

2.4.4.2 Information Transfer Phase

After having both received a UA response to a SARM command transmitted to the DTE and transmitted a UA response to a SARM command received from the DTE, the DCE will accept and transmit I and S frames according to the procedures described in 2.4.6

below.

When receiving a SARM command, the DCE will conform to the resetting procedure described in 2.4.7 below. The DTE may also receive a SARM command according to this resetting procedure.

2.4.4.3 Link Disconnection

During the information transfer phase the DTE shall indicate a request for disconnecting the link by transmitting a DISC command to the DCE.

Whenever receiving a DISC command, the DCE will return a UA response to the DTE.

During an information transfer phase, should the DCE wish to indicate a request for disconnecting the link, or when receiving from the DTE a first DISC command as a request for disconnecting the link, the DCE will transmit a DISC command to the DTE and start Timer T1 (2.4.11.1 below). The DTE will confirm reception of the DISC command by returning a UA response. After transmitting a SARM command, the DCE will not transmit a DISC command until a UA response is received for this SARM command or until Timer T1 runs out.

When receiving a UA response to the DISC command, the DCE will stop its Timer T1. If Timer T1 runs out before a UA response is received by the DCE, the DCE will transmit a DISC command and restart Timer T1. After transmission of DISC N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5 Procedures for Link Set-up and Disconnection (Applicable to LAPB)

2.4.5.1 Link Set-up

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

Whenever receiving an SABM command, the DCE will return a UA response to the DTE and set both its send and receive state variables V(S) and V(R) to 0.

Should the DCE wish to set-up the link, it will send the SABM command and start Timer T1 (see 2.4.11.1 below). Upon reception of the UA response from the DTE the DCE resets both its send and receive state variables V(S) and V(R) to 0 and stops its Timer T1.

Should T1 expire before reception of the UA response from the DTE, the DCE will retransmit the SABM command and restart Timer T1. After transmission of the SABM command N2 times by the DCE,

appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5.2 Information Transfer Phase

After having transmitted the UA response to an SABM command or having received the UA response to a transmitted SABM command, the DCE will accept and transmit I and S frames according to the procedures described in 2.4.6 below.

When receiving an SABM command while in the information transfer phase, the DCE will conform to the resetting procedure described in 2.4.9 below.

2.4.5.3 Link Disconnection

During the information transfer phase, the DTE shall indicate disconnecting of the link by transmitting a DISC command to the DCE.

When receiving a DISC command, the DCE will return a UA response to the DTE and enter the disconnected phase.

Should the DCE wish to disconnect the link, it will send the DISC command and start Timer T1 (see 2.4.11.1 below). Upon reception of the UA response from the DTE, the DCE will stop its Timer T1.

Should Timer T1 expire before reception of the UA response from the DTE, the DCE will retransmit the DISC command and restart Timer T1. After transmission of the DISC command N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5.4 Disconnected Phase

2.4.5.4.1 After having received a DISC command from the DTE and returned a UA response to the DTE, or having received the UA response to a transmitted DISC command, the DCE will enter the disconnected phase.

In the disconnected phase, the DCE may initiate link set-up. In the disconnected phase, the DCE will react to the receipt of an SABM command as described in 2.4.5.1 above and will transmit a DM response in answer to a received DISC command.

When receiving any other command frame with the P bit set to 1, the DCE will transmit a DM response with the F bit set to 1.

Other frames received in the disconnected phase will be ignored by the DCE.

2.4.5.4.2 When the DCE enters the disconnected phase after detecting error conditions as listed in 2.4.10 below, or exceptionally after recovery from an internal temporary malfunction it may also indicate this by sending a DM response rather than a DISC command. In these cases, the DCE will transmit DM and start its Timer T1 (see 2.4.11.1 below). If Timer T1 runs out before the reception of an SABM or DISC command from the DTE, the DCE will retransmit the DM response and restart Timer T1.

After transmission of the DM response N2 times, the DCE will remain in the disconnected phase and appropriate recovery actions will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5.5 Collision of Unnumbered Commands

Collision situations shall be resolved in the following way.

2.4.5.5.1 If the sent and received U commands are the same, the DTE and DCE shall send the UA response at the earliest possible opportunity. The DCE shall enter the indicated phase after receiving the UA response.

2.4.5.5.2 If the sent and received U commands are different, the DTE and DCE shall enter the disconnected phase and issue a DM response at the earliest possible opportunity.

2.4.5.6 Collision of DM Response with SABM or DISC Command

When a DM response is issued by the DCE as an unsolicited response to request the DTE to issue a mode-setting command as described in 2.4.5.4.2, a collision between a SABM or DISC command issued by the DTE and the unsolicited DM response issued by the DCE may occur. In order to avoid misinterpretation of the DM received, it is suggested that the DTE always will send its SABM or DISC command with the P bit set to 1.

2.4.6 Procedures for Information Transfer (Applicable to Both LAP and LAPB)

The procedures which apply to the transmission of I frames in each direction during the information transfer phase are described below.

In the following, "number one higher" is in reference to a continuously repeated sequence series, i.e., 7 is one higher than 6 and 0 is one higher than 7 for modulo eight series.

2.4.6.1 Sending I Frames

When the DCE has an I frame to transmit (i.e., an I frame not already transmitted, or having to be retransmitted as described in 2.4.6.5 below), it will transmit it with an N(S) equal to its current send state variable V(S), and an N(R) equal to its

current receive state variable V(R). At the end of the transmission of the I frame, it will increment its send state variable V(S) by one.

If the Timer T1 is not running at the instant of transmission of an I frame, it will be started.

If the send state variable V(S) is equal to the last value of N(R) received plus k (where k is the maximum number of outstanding I frames - see 2.4.11.4 below) the DCE will not transmit any new I frames, but may retransmit an I frame as described in 2.4.6.5 or 2.4.6.8 below.

Note: In order to ensure security of information transfer, the DTE should not transmit any I frame if its send state variable V(S) is equal to the last value of N(R) it has received from the DCE plus 7.

When the DCE is in the busy condition it may still transmit I frames, provided that the DTE is not busy itself. When the DCE is in the command rejection condition (LAP), it may still transmit I frames. When the DCE is in the frame rejection condition (LAPB), it will stop transmitting I frames.

2.4.6.2 Receiving an I Frame

2.4.6.2.1 When the DCE is not in a busy condition and receives with the correct FCS an I frame whose send sequence number is equal to the DCE receive state variable V(R), the DCE will accept the information field of this frame, increment by one its receive state variable V(R), and act as follows:

i) If an I frame is available for transmission by the DCE, it may act as in 2.4.6.1 above and acknowledge the received I frame by setting N(R) in the control field of the next transmitted I frame to the value of the DCE receive state variable V(R). The DCE may also acknowledge the received I frame by transmitting an RR with the N(R) equal to the value of the DCE receive state variable V(R).

ii) If no I frame is available for transmission by the DCE, it will transmit an RR with the N(R) equal to the value of the DCE receive state variable V(R).

2.4.6.2.2 When the DCE is in a busy condition, it may ignore the information field contained in any received I frame.

Note: Zero length information fields shall not be passed to the Packet Level and this situation should be indicated to the Packet Level.

2.4.6.3 Reception of Incorrect Frames

When the DCE receives a frame with an incorrect FCS or receives an invalid frame (see 2.2.9), this frame will be discarded.

When the DCE receives an I frame whose FCS is correct, but whose send sequence number is incorrect, i.e., not equal to the current DCE receive state variable V(R), it will discard the information field of the frame and transmit an REJ response with the N(R) set to one higher than the N(S) of the last correctly received I frame. The DCE will then discard the information field of all I frames until the expected I frame is correctly received. When receiving the expected I frame, the DCE will then acknowledge the frame as described in 2.4.6.2 above. The DCE will use the N(R) and P bit indications in the discarded I frames.

2.4.6.4 Receiving Acknowledgement

When correctly receiving an I or S frame (RR, RNR or REJ), even in the busy or command rejection condition, the DCE will consider the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to and including the received N(R) minus one. The DCE will reset the Timer T1 when it correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some I frames).

If the timer has been reset, and if there are outstanding I frames still unacknowledged, it will restart the Timer T1. If the timer then runs out, the DCE will follow the retransmission procedure (in 2.4.6.5 and 2.4.6.8 below) with respect to the unacknowledged I frames.

2.4.6.5 Receiving Reject

When receiving an REJ, and DCE will set its send state variable V(S) to the N(R) received in the REJ control field. It will transmit the corresponding I frame as soon as it is available or retransmit it. (Re)transmission will conform to the following:

i) If the DCE is transmitting a supervisory or unnumbered command or response when it receives the REJ, it will complete that transmission before commencing transmission of the requested I frame.

ii) If the DCE is transmitting an I frame when the REJ is received, it may abort the I frame and commence transmission of the requested I frame immediately after abortion.

iii) If the DCE is not transmitting any frame when the REJ is received, it will commence transmission of the requested I frame immediately.

In all cases, if other unacknowledged I frames had already been transmitted following the one indicated in the REJ, then those I frames will be retransmitted by the DCE following the retransmission of the requested I frame.

If the REJ frame was received from the DTE as a command with the P bit set to 1, the DCE will transmit an RR or RNR response with the F bit set to 1 before transmitting or retransmitting the corresponding I frame.

2.4.6.6 Receiving RNR

After receiving an RNR, the DCE may transmit or retransmit the I frame with the send sequence number equal to the N(R) indicated in the RNR. If the Timer T1 runs out after the reception of RNR, the DCE will follow the procedure described in 2.4.6.8 below. In any case the DCE will not transmit any other I frames before receiving an RR or REJ.

2.4.6.7 DCE Busy Condition

When the DCE enters a busy condition, it will transmit an RNR response at the earliest opportunity. While in the busy condition, the DCE will accept and process S frames and return an RNR response with the F bit set to 1 if it receives an S or I command frame with the P bit set to 1. To clear the busy condition, the DCE will transmit either an REJ response or an RR response with N(R) set to the current receive state variable V(R) depending on whether or not it discarded information fields of correctly received I frames.

Note: The DTE when encountering a DCE busy condition, may send supervisory command frames with the P bit set to 1. In the event that the DTE has not implemented supervisory commands, it may follow the procedures of the DCE (see 2.4.6.6) (applicable to LAPB).

2.4.6.8 Waiting Acknowledgement

The DCE maintains an internal retransmission count variable which is set to 0 when the DCE receives a UA or RNR, or when the DCE correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding I frames).

If the Timer T1 runs out, the DCE will (re-)enter the timer recovery condition, add one to its retransmission count variable and set an internal variable X to the current value of its send state variable.

The DCE will restart Timer T1, set its send state variable to the last N(R) received from the DTE and retransmit the corresponding I frame with the P bit set to 1 (LAP or LAPB) or transmit an

appropriate supervisory command with the P bit set to 1 (LAPB only).

The timer recovery condition is cleared when the DCE receives a valid S frame from the DTE, with the F bit set to 1.

If, while in the timer recovery condition, the DCE correctly receives a supervisory frame with the F bit set to 1 and with the N(R) within the range from its current send state variable to X included, it will clear the timer recovery condition and set its send state variable to the received N(R).

If, while in the timer recovery condition, the DCE correctly receives a supervisory frame with the F bit set to 0 and with an N(R) within the range from its current send state variable to X included, it will not clear the timer recovery condition. The received N(R) may be used to update the send state variable. However, the DCE may decide to keep the last transmitted I frame in store (even if it is acknowledged) in order to be able to retransmit it with the P bit set to 1 when Timer T1 expires at a later time.

If the retransmission count variable is equal to N2, the DCE initiates a resetting procedure for the direction of transmission from the DCE as described in 2.4.7.3, 2.4.9.2 or 2.4.9.3 below. N2 is a system parameter (see 2.4.11.2 below).

Note: Although the DCE will implement the internal variable X, other mechanisms do exist that achieve the identical functions. Therefore, the internal variable X is not necessarily implemented in the DTE.

2.4.7 Procedures for Resetting (Applicable to LAP)

2.4.7.1 The resetting procedure is used to reinitialize one direction of information transmission, according to the procedure described below. The resetting procedure only applies during the information transfer phase.

2.4.7.2 The DTE will indicate a resetting of the information transmission from the DTE by transmitting an SARM command to the DCE. When receiving an SARM command, the DCE will return, at the earliest opportunity, a UA response to the DTE and set its receive state variable V(R) to 0. This also indicates a clearance of the DCE busy condition, if present.

2.4.7.3 The DCE will indicate a resetting of the information transmission from the DCE by transmitting an SARM command to the DTE and will start Timer T1 (see 2.4.11.1 below). The DTE will confirm reception of the SARM command by returning a UA response to the DCE. When receiving this UA response to the SARM command, the DCE will set its send state variable to 0 and stop its Timer T1. If Timer T1 runs out before the UA response is received by

the DCE, the DCE will retransmit an SARM command and restart Timer T1. After transmission of SARM N2 times, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

The DCE will not act on any received response frame which arrives before the UA response to the SARM command. The value of N(R) contained in any correctly received I command frames arriving before the UA response will also be ignored.

2.4.7.4 When receiving a CMDR response from the DTE, the DCE will initiate a resetting of the information transmission from the DCE as described in 2.4.7.3 above.

2.4.7.5 If the DCE transmits a CMDR response, it enters the command rejection condition. This command rejection condition is cleared when the DCE receives an SARM or DISC command. Any other command received while in the command rejection condition will cause the DCE to retransmit this CMDR response. The coding of the CMDR response will be as described in 2.3.4.10 above.

2.4.8 Rejection Conditions (Applicable to LAP)

2.4.8.1 Rejection Conditions Causing a Resetting of the Transmission of Information from the DCE

The DCE will initiate a resetting procedure as described in 2.4.7.3 above when receiving a frame with the correct FCS, with the address A (coded 1 1 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the responses used;
- the information field is invalid;
- the N(R) contained in the control field is invalid;
- the response contains an F bit set to 1 except during a timer recovery condition as described in 2.4.6.8 above.

The DCE will also initiate a resetting procedure as described in 2.4.7.3 above when receiving an I frame with correct FCS, with the address B (coded 1 0 0 0 0 0 0 0) and with an invalid N(R) contained in the control field.

A valid N(R) must be within the range from the lowest send sequence number N(S) of the still unacknowledged frame(s) to the current DCE send state variable included, even if the DCE is in a rejection condition, but not if the DCE is in the timer recovery condition (see 2.4.6.8 above).

2.4.8.2 <u>Rejection Conditions Causing the DCE to Request a Resetting of the Transmission of Information from the DTE</u>

The DCE will enter the command rejection condition as described in 2.4.7.5 above when receiving a frame with the correct FCS, with the address B (coded 1 0 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the commands used;

- the information field is invalid.

2.4.9 <u>Procedures for Resetting (Applicable to LAPB)</u>

2.4.9.1 The resetting procedures are used to initialize both directions of information transmission according to the procedure described below. The resetting procedures only apply during the information transfer phase.

2.4.9.2 The DTE or DCE shall indicate a resetting by transmitting an SABM command. After receiving an SABM command, the DCE or DTE, respectively, will return, at the earliest opportunity, a UA response to the DTE or DCE, respectively, and reset its send and receive state variables V(S) and V(R) to 0. This also clears a DCE and/or DTE busy condition, if present. Prior to initiating this link resetting procedure, the DTE or DCE may initiate a disconnect procedure as described in 2.4.5.3 above.

2.4.9.3 Under certain rejection conditions listed in 2.4.6.8 above and 2.4.10.2 below, the DCE may ask the DTE to reset the link by transmitting a DM response.

After transmitting a DM response, the DCE will enter the disconnected phase as described in 2.4.5.4.2 above.

2.4.9.4 Under certain rejection conditions listed in 2.4.10.1 below, the DCE may ask the DTE to reset the link by transmitting a FRMR response.

After transmitting a FRMR response, the DCE will enter the frame rejection condition. The frame rejection condition is cleared when the DCE receives an SABM or DISC command or DM response. Any other command received while in the frame rejection condition will cause the DCE to retransmit the FRMR response with the same information field as originally transmitted.

The DCE may start a Timer T1 on transmission of the FRMR response. If Timer T1 runs out before the reception of an SABM or DISC command from the DTE, the DCE may retransmit the FRMR response and restart Timer T1. After transmission of the FRMR response N2 times the DCE may reset the link as described in 2.4.9.2 above. The value of N2 is defined in 2.4.11.2 below.

2.4.10 Rejection Conditions (Applicable to LAPB)

2.4.10.1 The DCE will initiate a resetting procedure as described in 2.4.9.4 above, when receiving, during the information transfer phase, a frame with the correct FCS, with the address A or B, and with one of the following conditions:

- the frame is unknown as a command or as a response;
- the information field is invalid;
- the N(R) contained in the control field is invalid as described in 2.4.8.1 above.

The coding of the information field of the FRMR response which is transmitted is given in 2.3.4.10 above. Bit 13 of this information field is set to 0 if the address of the rejected frame is B. It is set to 1 if the address is A.

2.4.10.2 The DCE will initiate a resetting procedure as described in 2.4.9.2 or 2.4.9.3 above when receiving during the information transfer phase a DM response or a FRMR response.

The DCE may initiate a resetting procedure as described in 2.4.9.2 or 2.4.9.3 above when receiving during the information transfer phase a UA response or an unsolicited response with the F bit set to 1.

2.4.11 List of System Parameters (Applicable to Both LAP and LAPB)

The system parameters are as follows:

2.4.11.1 Timer T1

The period of the Timer T1 will take into account whether the timer is started at the beginning or the end of the frame in the DCE.

The period of the Timer T1, at the end of which retransmission of a frame may be initiated according to the procedures described in 2.4.4 to 2.4.6 above, is a system parameter agreed for a period of time with the Administration.

The proper operation of the procedure requires that Timer T1 be greater than the maximum time between transmission of frames (SARM, SABM, DM, DISC, FRMR, I or supervisory commands) and the reception of the corresponding frame returned as an answer to this frame (UA, DM or acknowledging frame). Therefore, the DTE should not delay the response or acknowledging frame returned to the above frames by more than a value T2 less than T1, where T2 is a system parameter.

The DCE will not delay the response or acknowledging frame returned to a command by more than T2.

2.4.11.2 Maximum Number of Transmissions N2

The value of the maximum number N2 of transmission and retransmissions of a frame following the running out of Timer T1 is a system parameter agreed for a period of time with the Administration.

2.4.11.3 Maximum Number of Bits in an I Frame N1

The maximum number of bits in an I frame is a system parameter which depends upon the maximum length of the information fields transferred across the DTE/DCE interface.

2.4.11.4 Maximum Number of Outstanding I Frames k

The maximum number (k) of sequentially numbered I frames that the DTE or DCE may have outstanding (i.e., unacknowledged) at any given time is a system parameter which can never exceed seven. It shall be agreed for a period of time with the Administration.

Note: As a result of the further study proposed in 2.2.4 above, the permissible maximum number of outstanding I frames may be increased.

3. DESCRIPTION OF THE PACKET LEVEL DTE/DCE INTERFACE

This and subsequent sections of the recommendation relate to the transfer of packets at the DTE/DCE interface. The procedures apply to packets which are successfully transferred across the DTE/DCE interface.

Each packet to be transferred across the DTE/DCE interface shall be contained within the link level information field which will delimit its length, and only one packet shall be contained in the information field.

Note 1: Possible insertion of more than one packet in the link level information field is for further study.

Note 2: At present, some networks require the data fields of packets to contain an integral number of octets. The transmission by the DTE of data fields not containing an integral number of octets to the network may cause a loss of data integrity.

Under urgent study are further considerations regarding the trends of future requirements and implementations toward either bit-orientation (any number of bits) or

octet-orientation (an integral number of octets) for data fields in X.25 packets.

DTEs wishing universal operation on all networks should transmit all packets with data fields containing only an integral number of octets. Full data integrity can only be assured by exchange of octet-oriented data fields in both directions of transmission.

This section covers a description of the packet level interface for virtual call, permanent virtual circuit and datagram services. As designated in Recommendation X.2, virtual call and permanent virtual circuit services are essential (E) services to be provided by all networks. Datagram service is designated as an additional (A) service which may be provided by some networks.

Note: Under study are considerations regarding the amount of possible duplication between datagram, fast select and possible additional virtual call enhancements with the objective to minimize the variety of interfaces.

Procedures for virtual circuit service (i.e., virtual call and permanent virtual circuit services) are specified in section 4. Procedures for the datagram service are specified in section 5. Packet formats for all services are specified in section 6. Procedures and formats for optional user facilities are specified in section 7.

3.1 Logical Channels

To enable simultaneous virtual calls and/or permanent virtual circuits and/or datagrams, logical channels are used. Each virtual call, permanent virtual circuit, and datagram channel is assigned a Logical Channel Group Number (less than or equal to 15) and a Logical Channel Number (less than or equal to 255). For virtual calls, a Logical Channel Group Number and a Logical Channel Number are assigned during the call set-up phase. The range of logical channels used for virtual calls is agreed with the Administration at the time of subscription to the service (see Annex 1). For permanent virtual circuits and datagram channels, Logical Channel Group Numbers and Logical Channel Numbers are assigned in agreement with the Administration at the time of subscription to the service (see Annex 1).

3.2 Basic Structure of Packets

Every packet transferred across the DTE/DCE interface consists of at least 3 octets. These three octets contain a general format identifier, a logical channel identifier and a packet type identifier. Other packet fields are appended as required (see section 6).

Packet types and their use in association with various services are given in Table 3.1/X.25.

TABLE 3.1/X.25

PACKET TYPES AND THEIR USE IN VARIOUS SERVICES

PACKET TYPE		SERVICE		
FROM DCE TO DTE	FROM DTE TO DCE	VC	PVC	DG*
CALL SET-UP AND CLEARING (Note 1)				
INCOMING CALL	CALL REQUEST	X		
CALL CONNECTED	CALL ACCEPTED	X		
CLEAR INDICATION	CLEAR REQUEST	X		
DCE CLEAR CONFIRMATION	DTE CLEAR CONFIRMATION	X		
DATA AND INTERRUPT (Note 2)				
DCE DATA	DTE DATA	X	X	
DCE INTERRUPT	DTE INTERRUPT	X	X	
DCE INTERRUPT CONFIRMATION	DTE INTERRUPT CONFIRMATION	X	X	
DATAGRAM (Note 3)				
DCE DATAGRAM	DTE DATAGRAM			X
DATAGRAM SERVICE SIGNAL				X
FLOW CONTROL AND RESET (Note 4)				
DCE RR	DTE RR	X	X	X
DCE RNR	DTE RNR	X	X	X
	DTE REJ*	X	X	X
RESET INDICATION	RESET REQUEST	X	X	X
DCE RESET CONFIRMATION	DTE RESET CONFIRMATION	X	X	X
RESTART (Note 5)				
RESTART INDICATION	RESTART REQUEST	X	X	X
DCE RESTART CONFIRMATION	DTE RESTART CONFIRMATION	X	X	X
DIAGNOSTIC (Note 6)				
DIAGNOSTIC*		X	X	X

* Not necessarily available on all networks.

VC = Virtual call
PVC = Permanent virtual circuit
DG = Datagram

<u>Note 1</u>: See sections 4.1 and 7.2.4 for procedures and sections 6.2 and 6.8.2 for formats.

<u>Note 2</u>: See section 4.3 for procedures and section 6.3 for formats.

<u>Note 3</u>: See section 5.1 for procedures and section 6.4 for formats.

<u>Note 4</u>: See sections 4.4, 5.2 and 7.1.4 for procedures and section 6.5 and 6.8.1 for formats.

<u>Note 5</u>: See section 3.3 for procedures and section 6.6 for formats.

<u>Note 6</u>: See section 3.4 for procedures and section 6.7 for formats.

3.3 Procedure for Restart

The restart procedure is used to initialize or re-initialize the packet level DTE/DCE interface. The restart procedure simultaneously clears all the virtual calls and resets all the permanent virtual circuits and datagram channels at the DTE/DCE interface (see sections 4.5 and 5.3).

Annex 2, Figure A2.1/X.25 gives the state diagram which defines the logical relationships of events related to the restart procedure.

Annex 3, Table A3.2/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE for the restart procedure. Details of the action which should be taken by the DTE are for further study.

3.3.1 Restart by the DTE

The DTE may at any time request a restart by transferring across the DTE/DCE interface a RESTART REQUEST packet. The interface for each logical channel is then in the DTE RESTART REQUEST state (r2).

The DCE will confirm the restart by transferring a DCE RESTART CONFIRMATION packet placing the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

<u>Note</u>: States p1 and d1 are specified in sections 4 and 5.

The DCE RESTART CONFIRMATION packet can only be interpreted universally as having local significance. The time spent in the DTE RESTART REQUEST state (r2) will not exceed time-limit T20

(see Annex 4).

3.3.2 Restart by the DCE

The DCE may indicate a restart by transferring across the DTE/DCE interface a RESTART INDICATION packet. The interface for each logical channel is then in the DCE RESTART INDICATION state (r3). In this state of the DTE/DCE interface, the DCE will ignore all packets except for RESTART REQUEST and DTE RESTART CONFIRMATION.

The DTE will confirm the restart by transferring a DTE RESTART CONFIRMATION packet placing the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

The action taken by the DCE when the DTE does not confirm the restart within time-out T10 is given in Annex 4.

3.3.3 Restart Collision

Restart collision occurs when a DTE and a DCE simultaneously transfer a RESTART REQUEST and a RESTART INDICATION packet. Under this circumstance, the DCE will consider that the restart is completed. The DCE will not expect a DTE RESTART CONFIRMATION packet and will not transfer a DCE RESTART CONFIRMATION packet. This places the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

3.4 Error Handling

Table A3.1/X.25 specifies the reaction of the DCE when special error conditions are encountered. Other error conditions are discussed in sections 4 and 5.

3.4.1 Diagnostic Packet

The DIAGNOSTIC packet is used by some networks to indicate error conditions under circumstances when the usual methods of indication (i.e., reset, clear and restart with cause and diagnostic) are inappropriate (see Tables A3.1/X.25 and A4.1/X.25). The DIAGNOSTIC packet from the DCE supplies information on error situations which are considered unrecoverable at the packet level of X.25; the information provided permits an analysis of the error and recovery by higher levels at the DTE if desired or possible.

A DIAGNOSTIC packet is issued only once per particular instance of an error condition. No confirmation is required to be issued by the DTE on receipt of a DIAGNOSTIC packet. After issuance of a DIAGNOSTIC packet, the DCE maintains the logical channel(s) to

which the DIAGNOSTIC packet is related in the same state as that when the DIAGNOSTIC packet was generated.

3.5 Effects of the Physical Level and the Link Level on the Packet Level

Changes of operational states of the physical level and the link level of the DTE/DCE interface do not implicitly change the state of each logical channel at the packet level. Such changes when they occur are explicitly indicated at the packet level by the use of restart, clear or reset procedures as appropriate.

A failure on the physical and/or link level is defined as a condition in which the DCE cannot transmit and receive any frames because of abnormal conditions caused by, for instance, a line fault between DTE and DCE.

When a failure on the physical and/or link level is detected, virtual calls will be cleared, permanent virtual circuits will be declared out of order and queued datagrams will be discarded. Further actions are specified in section 4.6 for virtual circuit services and in section 5.4 for the datagram service.

When the failure is recovered on physical and link levels, the DCE will send a RESTART INDICATION packet with the cause "Network operational" to the local DTE. Further actions are specified in section 4.6 for virtual circuit services and in section 5.4 for the datagram service.

In other out of order conditions on the physical and/or link level, including transmission of a DISC command by the DTE, the behavior of the DCE is for further study.

4. PROCEDURES FOR VIRTUAL CIRCUIT SERVICES

4.1 Procedures for Virtual Call Service

Annex 2, Figures A2.1/X.25, A2.2/X.25 and A2.3/X.25 show the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel used for virtual calls.

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 2. Details of the actions which should be taken by the DTE are for further study.

The call set-up and clearing procedures described in the following sections apply independently to each logical channel assigned to virtual call service at the DTE/DCE interface.

4.1.1 Ready State

If there is no call in existence, a logical channel is in the READY state (p1).

4.1.2 Call Request Packet

The calling DTE shall indicate a call request by transferring a CALL REQUEST packet across the DTE/DCE interface. The logical channel selected by the DTE is then in the DTE WAITING state (p2). The CALL REQUEST packet includes the called DTE address. The calling DTE address field may also be used.

Note 1: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

Note 2: The CALL REQUEST packet should use the logical channel in the READY state with the highest number in the range which has been agreed with the Administration (see Annex 1). Thus the risk of call collision is minimized.

4.1.3 Incoming Call Packet

The DCE will indicate that there is an incoming call by transferring across the DTE/DCE interface an INCOMING CALL packet. This places the logical channel in the DCE WAITING state (p3).

The INCOMING CALL packet will use the logical channel in the READY state with the lowest number (see Annex 1). The INCOMING CALL packet includes the calling DTE address. The called DTE address field may also be used.

Note: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

4.1.4 Call Accepted Packet

The called DTE shall indicate its acceptance of the call by transferring across the DTE/DCE interface a CALL ACCEPTED packet specifying the same logical channel as that of the INCOMING CALL packet. This places the specified logical channel in the DATA TRANSFER state (p4).

If the called DTE does not accept the call by a CALL ACCEPTED packet or does not reject it by a CLEAR REQUEST packet as described in section 4.1.7 within time-out T11 (see Annex 4), the DCE will consider it as a procedure error from the called DTE and will clear the virtual call according to the procedure described in section 4.1.8.

4.1.5 Call Connected Packet

The receipt of a CALL CONNECTED packet by the calling DTE specifying the same logical channel as that specified in the CALL REQUEST packet indicates that the call has been accepted by the called DTE by means of a CALL ACCEPTED packet. This places the specified logical channel in the DATA TRANSFER state (p4).

The time spent in the DTE WAITING state (p2) will not exceed time-limit T21 (see Annex 4).

4.1.6 Call Collision

Call collision occurs when a DTE and DCE simultaneously transfer a CALL REQUEST packet and an INCOMING CALL packet specifying the same logical channel. The DCE will proceed with the call request and cancel the incoming call.

4.1.7 Clearing by the DTE

At any time the DTE may indicate clearing by transferring across the DTE/DCE interface a CLEAR REQUEST packet (see section 4.5). The logical channel is then in the DTE CLEAR REQUEST state (p6). When the DCE is prepared to free the logical channel, the DCE will transfer across the DTE/DCE interface a DCE CLEAR CONFIRMATION packet specifying the logical channel. The logical channel is now in the READY state (p1).

The DCE CLEAR CONFIRMATION packet can only be interpreted universally as having local significance, however within some Administration's networks clear confirmation may have end to end significance. In all cases the time spent in the DTE CLEAR REQUEST state (p6) will not exceed time-limit T23 (see Annex 4).

It is possible that subsequent to transferring a CLEAR REQUEST packet the DTE will receive other types of packets, dependent on the state of the logical channel, before receiving a DCE CLEAR CONFIRMATION packet.

Note: The calling DTE may abort a call by clearing it before it has received a CALL CONNECTED or CLEAR INDICATION packet.

The called DTE may refuse an incoming call by clearing it as described in this section rather than transmitting a CALL ACCEPTED packet as described in section 4.1.4.

4.1.8 Clearing by the DCE

The DCE will indicate clearing by transferring across the DTE/DCE interface a CLEAR INDICATION packet (see section 4.5). The logical channel is then in the DCE CLEAR INDICATION state (p7). The DTE shall respond by transferring across the DTE/DCE interface a

DTE CLEAR CONFIRMATION packet. The logical channel is now in the READY state (p1).

The action taken by the DCE when the DTE does not confirm clearing within time-out T13 is given in Annex 4.

4.1.9 Clear Collision

Clear collision occurs when a DTE and a DCE simultaneously transfer a CLEAR REQUEST packet and a CLEAR INDICATION packet specifying the same logical channel. Under this circumstance the DCE will consider that the clearing is completed. The DCE will not expect a DTE CLEAR CONFIRMATION packet and will not transfer a DCE CLEAR CONFIRMATION packet. This places the logical channel in the READY state (p1).

4.1.10 Unsuccessful Call

If a call cannot be established, the DCE will transfer a CLEAR INDICATION packet specifying the logical channel indicated in the CALL REQUEST packet.

4.1.11 Call Progress Signals

The DCE will be capable of transferring to the DTE clearing call progress signals as specified in Recommendation X.96.

Clearing call progress signals will be carried in CLEAR INDICATION packets which will terminate the call to which the packet refers. The method of coding CLEAR INDICATION packets containing call progress signals is detailed in section 6.2.3.

4.1.12 Data Transfer State

The procedures for the control of packets between DTE and DCE while in the DATA TRANSFER state are contained in section 4.3.

4.2 Procedures for Permanent Virtual Circuit Service

Annex 2, Figures A2.1/X.25 and A2.3/X.25 show the state diagrams which give a definition of events at the packet level DTE/DCE interface for logical channels assigned for permanent virtual circuits.

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 2. Details of the action which should be taken by the DTE are for further study.

For permanent virtual circuits there is no call set-up or clearing. The procedures for the control of packets between DTE and DCE while in the DATA TRANSFER state are contained in section 4.3.

4.3 Procedures for Data and Interrupt Transfer

The data transfer and interrupt procedures described in the following subsections apply independently to each logical channel assigned for virtual calls or a permanent virtual circuit existing at the DTE/DCE interface.

Normal network operation dictates that user data in data and interrupt packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications. Order of bits in data packets is preserved. Packet sequences are delivered as complete packet sequences. DTE Diagnostic Codes are treated as described in sections 6.2.3, 6.5.3 and 6.6.1.

4.3.1 States for Data Transfer

A virtual call logical channel is in the DATA TRANSFER state (p4) after completion of call establishment and prior to a clearing or a restart procedure. A permanent virtual circuit logical channel is continually in the DATA TRANSFER state (p4) except during the restart procedure. Data, interrupt, flow control and reset packets may be transmitted and received by a DTE in the DATA TRANSFER state of a logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in section 4.4 apply to data transmission on that logical channel to and from the DTE.

When a virtual call is cleared, data and interrupt packets may be discarded by the network (see section 4.5). In addition data, interrupt, flow control and reset packets transmitted by a DTE will be ignored by the DCE when the logical channel is in the DCE CLEAR INDICATION state (p7). Hence it is left to the DTE to define DTE to DTE protocols able to cope with the various possible situations that may occur.

4.3.2 User Data Field Length of Data Packets

The standard maximum User Data field length is 128 octets.

In addition, other maximum User Data field lengths may be offered by Administrations from the following list: 16, 32, 64, 256, 512 and 1024 octets. An optional maximum User Data field length may be selected for a period of time as the default maximum User Data field length common to all virtual calls at the DTE/DCE interface (see section 7.2.1). A value other than the default may be selected for a period of time for each permanent virtual circuit (see section 7.2.1). Negotiation of maximum User Data field lengths on a per call basis may be made with the Flow Control Parameter Negotiation facility (see section 7.2.2).

The User Data field of data packets transmitted by a DTE or DCE may contain any number of bits up to the agreed maximum.

Note: At present, some networks require the User Data field to contain an integral number of octets (see section 3, Note 2).

If the User Data field in a data packet exceeds the locally permitted maximum User Data field length, then the DCE will reset the virtual call or permanent virtual circuit with the resetting cause "Local procedure error".

4.3.3 Delivery Confirmation Bit

The setting of the Delivery Confirmation bit (D bit) is used to indicate whether or not the DTE wishes to receive an end-to-end acknowledgment of delivery, for data it is transmitting, by means of the packet receive sequence number P(R) (see section 4.4).

Note 1: The use of the D bit procedure does not obviate the need for a higher level protocol agreed between the communicating DTEs which may be used with or without the D bit procedure to recover from user or network generated resets and clearings.

Note 2: After January 1982, the D bit procedure should be considered an integral part of this Recommendation. In the interim period, the D bit procedure will be available on some Public Data Networks and between some pairs of Public Data Networks on a bilateral basis.

During the interim period, Administrations of networks which do not provide the D bit procedure should be consulted to determine whether the significance of P(R) is a local updating of the window across the packet level DTE/DCE interface or conveys an end-to-end acknowledgement of delivery of data.

In order to facilitate the orderly introduction of the D bit procedures in DTEs and DCEs, the following mechanisms are provided.

The calling DTE can ascertain during call establishment that the D bit procedure can be used for the call by setting bit 7 in the General Format Identifier of the CALL REQUEST packet to 1 (see section 6.1.1). Every network or part of international network where the D bit procedure is available will pass this bit transparently. If the remote DTE is able to handle the D bit procedure, it should not regard this bit being set to 1 in the INCOMING CALL packet as invalid.

Likewise, the called DTE can set bit 7 in the General Format Identifier of the CALL ACCEPTED packet to 1. Every network or part of international network where the D bit is available will pass this bit transparently. If the calling DTE is able to handle the D bit procedure, it should not regard this bit being set to 1 in the CALL CONNECTED packet as invalid.

If any network along the path does not support the D bit procedure, this would be indicated by call clearing by the DCE with a cause indicating "Incompatible destination" and the diagnostic "Invalid general format identifier" or by any other means to indicate an invalid general format identifier at a DTE/DCE interface (see Table A3.1/X.25).

The use by the DTEs of the above mechanism in the CALL REQUEST and CALL ACCEPTED packets is recommended but is not mandatory for using the D bit procedure during the virtual call.

If a D bit is set to 1 in a data packet on a virtual call or permanent virtual circuit where the D bit is not available, this will be indicated to both DTEs by a RESET INDICATION packet with the cause "Incompatible destination" and the diagnostic "Invalid general format identifier", or by any other means to indicate an invalid general format identifier at a DTE/DCE interface (see Table A3.1/X.25).

4.3.4 More Data Mark

If a DTE or DCE wishes to indicate a sequence of more than one packet, it uses a More Data mark (M bit) as defined below.

The M bit can be set to 1 in any data packet. When it is set to 1 in a full data packet or in a partially full data packet also carrying the D bit set to 1, it indicates that more data is to follow. Recombination with the following data packet may be only performed within the network when the M bit is set to 1 in a full data packet which also has the D bit set to 0.

A sequence of data packets with every M bit set to 1 except for the last one will be delivered as a sequence of data packets with the M bit set to 1 except for the last one when the original packets having the M bit set to 1 are either full (irrespective of the setting of the D bit) or partially full but have the D bit set to 1.

Two categories of data packets, A and B, have been defined as shown in Table 4.1/X.25. Table 4.1/X.25 also illustrates the network's treatment of the M and D bits at both ends of a virtual call or permanent virtual circuit.

TABLE 4.1/X.25

DEFINITION OF TWO CATEGORIES OF DATA PACKETS AND NETWORK TREATMENT OF THE M and D BITS

Data Packet Sent by Source DTE				Combining with Subsequent Packet(s) is Performed by the Network when Possible	Data Packet* Received by Destination DTE	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0	0
B	0	1	No	No	0	1
B	1	1	No	No	1	1
B	0	0	Yes	No	0	0
B	0	1	Yes	No	0	1
A	1	0	Yes	Yes (see Note)	1	0
B	1	1	Yes	No	1	1

* Refers to the delivered data packet whose last bit of user data corresponds to the last bit of user data, if any, that was present in the data packet sent by the source DTE.

Note: If the data packet sent by the source DTE is combined with other packets, up to and including a category B packet, the M and D bit settings in the data packet received by the destination DTE will be according to that given in the two right hand columns for the last data packet sent by the source DTE that was part of the combination.

4.3.5 Complete Packet Sequence

A complete packet sequence is defined as being composed of a single category B packet and all contiguous preceeding category A packets (if any). Category A packets have the exact maximum User Data field length with the M bit set to 1 and the D bit set to 0. All other data packets are category B packets.

When transmitted by a source DTE, a complete packet sequence is always delivered to the destination DTE as a single complete packet sequence.

Thus, if the receiving end has a larger maximum data field length than the transmitting end, then packets within a complete packet sequence will be combined within the network. They will be delivered in a complete packet sequence where each packet, except the last one, has the exact maximum data field length, the M bit set to 1, and the D bit set to 0. The User Data field of the last packet of the sequence may have less than the maximum length and the M and D bits are set as described in Table 4.1/X.25.

If the maximum data field length is the same at both ends, then data fields of data packets are delivered to the receiving DTE exactly as they have been received by the network, except as follows. If a full packet with the M bit set to 1 and the D bit set to 0 is followed by an empty packet, then the two packets may be merged so as to become a single category B full packet. If the last packet of a complete packet sequence transmitted by the source DTE has a User Data field less than the maximum length with the M bit set to 1 and the D bit set to 0, then the last packet of the complete packet sequence delivered to the receiving DTE will have the M bit set to 0.

If the receiving end has a smaller maximum data field length than the transmitting end, then packets will be segmented within the network, and the M and D bits set by the network as described to maintain complete packet sequences.

4.3.6 <u>Qualifier Bit</u>

A complete packet sequence may be on one of two levels. If a DTE wishes to transmit data on more than one level, it uses an indicator called the Qualifier bit (Q bit).

When only one level of data is being transmitted on a logical channel, the Qualifier bit is always set to 0. If two levels of data are being transmitted, the transmitting DTE should set the Qualifier bit in all data packets of a complete packet sequence to the same value, either 0 or 1. A complete packet sequence, which is transmitted with the Qualifier bit set to the same value in all packets, is delivered by the network as a complete packet sequence with the Qualifier bit set in all packets to the value assigned by the transmitting DTE.

The action of the network when the Qualifier bit is not set to the same value by the transmitting DTE within a complete packet sequence is left for further study.

Recommendation X.29 gives an example of the procedures to be used when the Qualifier bit is set to 1.

Packets are numbered consecutively (see section 4.4.1.1) regardless of their data level.

4.3.7 Interrupt Procedure

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets (see section 4.4). The interrupt procedure can only apply in the FLOW CONTROL READY state (d1) within the DATA TRANSFER state (p4).

The interrupt procedure has no effect on the transfer and flow control procedures applying to the data packets on the virtual call or permanent virtual circuit.

To transmit an interrupt, a DTE transfers across the DTE/DCE interface a DTE INTERRUPT packet. The DTE should not transmit a second DTE INTERRUPT packet until the first one is confirmed with a DCE INTERRUPT CONFIRMATION packet (see Note 2 to Table A3.4/X.25). The DCE, after the interrupt procedure is completed at the remote end, will confirm the receipt of the interrupt by transferring a DCE INTERRUPT CONFIRMATION packet. The receipt of a DCE INTERRUPT CONFIRMATION packet indicates that the interrupt has been confirmed by the remote DTE by means of a DTE INTERRUPT CONFIRMATION packet.

The DCE indicates an interrupt from the remote DTE by transferring across the DTE/DCE interface a DCE INTERRUPT packet containing the same data field as in the DTE INTERRUPT packet transmitted by the remote DTE. A DCE INTERRUPT packet is delivered at or before the point in the stream of data packets at which the DTE INTERRUPT packet was generated. The DTE will confirm the receipt of the DCE INTERRUPT packet by transferring a DTE INTERRUPT CONFIRMATION packet.

4.4 Procedures for Flow Control

This subsection only applies to the DATA TRANSFER state (p4) and specifies the procedures covering flow control of data packets and reset on each logical channel used for a virtual call or a permanent virtual circuit.

4.4.1 Flow Control

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit, the transmission of data packets is controlled separately for each direction and is based on authorizations from the receiver.

On a virtual call or permanent virtual circuit, flow control also allows a DTE to limit the rate at which the remote DTE can transmit data packets. This is achieved by the receiving DTE controlling the rate at which it accepts packets across the DTE/DCE interface, noting that there is a network-dependent limit on the number of data packets which may be in the network on the virtual call or permanent virtual circuit.

4.4.1.1 Numbering of Data Packets

Each data packet transmitted at the DTE/DCE interface for each direction of transmission in a virtual call or permanent virtual circuit is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. Some Administrations will provide the Extended Packet Sequence Numbering facility (see section 7.1.1) which, if selected, provides a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127. The packet sequence numbering scheme, modulo 8 or 128, is the same for both directions of transmission and is common for all logical channels at the DTE/DCE interface.

Only data packets contain this sequence number called the packet send sequence number P(S).

The first data packet to be transmitted across the DTE/DCE interface for a given direction of data transmission, when the logical channel has just entered the FLOW CONTROL READY state (d1), has a packet send sequence number equal to 0.

4.4.1.2 Window Description

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit and for each direction of data transmission, a window is defined as the ordered set of W consecutive packet send sequence numbers of the data packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When a virtual call or permanent virtual circuit at the DTE/DCE interface has just entered the FLOW CONTROL READY state (d1), the window related to each direction of data transmission has a lower window edge equal to 0.

The packet send sequence number of the first data packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8, or 128 when extended).

The standard window size W is 2 for each direction of data transmission at the DTE/DCE interface. In addition, other window sizes may be offered by Administrations. An optional window size may be selected for a period of time as the default window size common to all virtual calls at the DTE/DCE interface (see section 7.1.2). A value other than the default may be selected for a period of time for each permanent virtual circuit (see section 7.1.2). Negotiation of window sizes on a per call basis may be made with the Flow Control Parameter Negotiation facility (see section 7.2.2).

4.4.1.3 Flow Control Principles

When the sequence number P(S) of the next packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this data packet to the DTE. When the sequence number P(S) of the next data packet to be transmitted by the DCE is outside of the window, the DCE shall not transmit a data packet to the DTE. The DTE should follow the same procedure.

When the sequence number P(S) of the data packet received by the DCE is the next in sequence and is within the window, the DCE will accept this data packet. A received data packet containing a P(S) that is out of sequence (i.e., there is a duplicate or a gap in the P(S) numbering), outside the window, or not equal to 0 for the first data packet after entering the FLOW CONTROL READY state (d1) is considered by the DCE as a local procedure error. The DCE will reset the virtual call or permanent virtual circuit (see section 4.4.3). The DTE should follow the same procedure.

Some networks do not invoke the error procedure on receipt of a data packet containing a P(S) that is out of sequence but is within the window. These networks may pass on such packets to the remote DTE in order to make it possible for the local DTE to retransmit packets on virtual calls or permanent virtual circuits (within the national network).

A number (modulo 8, or 128 when extended), referred to as a packet receive sequence number P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of data packets. When transmitted across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional data packets may be authorized by the receiver to cross the DTE/DCE interface.

The packet receive sequence number, P(R), is conveyed in data, receive ready (RR) and receive not ready (RNR) packets.

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE up to and including the packet send sequence number of the next data packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the virtual call or permanent virtual circuit. The DTE should follow the same procedure.

The receive sequence number P(R) is less than or equal to the sequence number of the next expected data packet and implies that the DTE or DCE transmitting P(R) has accepted <u>at least</u> all data packets numbered up to and including P(R)-1.

4.4.1.4 Delivery Confirmation

When the D bit is set to 0 in a data packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet [i.e., P(R) $\geq$ p+1] is a local updating of the window across the packet level interface so that the achievable throughput is not constrained by the DTE-to-DTE round trip delay across the network(s).

When the D bit is set to 1 in a data packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet [i.e., P(R) $\geq$ p+1] is an indication that a P(R) has been received from the remote DTE for all data bits in the data packet in which the D bit had originally been set to 1.

Note 1: A DTE, on receiving a data packet with the D bit set to 1, should transmit the corresponding P(R) as soon as possible in order to avoid the possibility of deadlocks (e.g., without waiting for further data packets). A data, RR or RNR packet may be used to convey the P(R) (see Note to section 4.4.1.6). Likewise, the DCE is required to send P(R) to the DTE as soon as possible from when the P(R) is received from the remote DTE.

Note 2: In the case where a P(R) for a data packet with the D bit set to 1 is outstanding, local updating of the window will be deferred for subsequent data packets with the D bit set to 0. Some networks may also defer updating the window for previous data packets (within the window) with the D bit set to 0 until the corresponding P(R) for the packet with the outstanding D bit set to 1 is transmitted to the DTE.

Note 3: P(R) values corresponding to the data contained in data packets with the D bit set to 1 need not be the same at the DTE/DCE interfaces at each end of a virtual call or a permanent virtual circuit.

4.4.1.5 DTE and DCE Receive Ready (RR) Packets

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W data packets within the window starting with P(R), where P(R) is indicated in the RR packet.

4.4.1.6 DTE and DCE Receive Not Ready (RNR) Packets

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional data packets for a given virtual call or permanent virtual circuit. A DTE or DCE receiving an RNR packet shall stop transmitting data packets on the indicated logical channel, but the window is updated by the P(R) value of the RNR packet. The receive not ready situation indicated by the transmission of an RNR packet is cleared by the transmission in

the same direction of an RR packet or by a reset procedure being initiated.

The transmission of an RR packet after an RNR packet at the packet level is not to be taken as a demand for retransmission of packets which have already been transmitted.

Note: The RNR packet may be used to convey across the DTE/DCE interface the P(R) value corresponding to a data packet which had the D bit set to 1 in the case that additional data packets cannot be accepted.

4.4.2 Throughput Characteristics and Throughput Classes

The attainable throughput on virtual calls and permanent virtual circuits carried at the DTE/DCE interface may vary due to the statistical sharing of transmission and switch resources and is constrained by:

(i) the access line characteristics, local window size and traffic characteristics of other logical channels at the local DTE/DCE interface,

(ii) the access line characteristics, local window size and traffic characteristics of other logical channels at the remote DTE/DCE interface, and

(iii) the throughput achievable on the virtual call or permanent virtual circuit through the network(s) independent of interface characteristics including number of active logical channels. This throughput may be dependent on network service characteristics such as window rotation mechanisms and/or optional user facilities requested on national/international calls.

The attainable throughput will also be affected by:

(i) the receiving DTE flow controlling the DCE,

(ii) the transmitting DTE not sending data packets which have the maximum data field length,

(iii) the local DTE/DCE window and/or packet sizes, and

(iv) the use of the D bit.

A throughput class for one direction of transmission is an inherent characteristic of the virtual call or permanent virtual circuit related to the amount of resources allocated to this virtual call or permanent virtual circuit. This characteristic is meaningful when the D bit is set to 0 in data packets. It is a measure of the throughput that is not normally exceeded on the virtual call or permanent virtual circuit. However, due to the

statistical sharing of transmission and switching resources, it is not guaranteed that the throughput class can be reached 100% of the time.

Depending on the network and the applicable conditions at the considered moment, the effective throughput may exceed the throughput class.

Note: The definition of throughput class as a grade of service parameter is for further study. The grade of service might be specified when the D bit is set to 0 or over a time period between the completion and initiation of successive D bit procedures.

The throughput class may only be reached if the following conditions are met:

(a) the access data links of both ends of a virtual call or permanent virtual circuit are engineered for the throughput class;

(b) the receiving DTE is not flow controlling the DCE such that the throughput class is not reachable;

(c) the transmitting DTE is sending data packets which have the maximum data field length; and

(d) all data packets transmitted on the virtual call or permanent virtual circuit have the D bit set to 0.

The throughput class is expressed in bits per second. At a DTE/DCE interface, the maximum data field length is specified for a virtual call or permanent virtual circuit, and thus the throughput class can be interpreted by the DTE as the number of full data packets/second that the DTE does not have a need to exceed.

In the absence of the Default Throughput Class Assignment facility (see section 7.1.3), the default throughput classes for both directions of transmission correspond to the user class of service of the DTE (see section 7.4.2.6) but do not exceed the maximum throughput class supported by the network. Negotiation of throughput classes on a per call basis may be made with the Throughput Class Negotiation facility (see section 7.2.3).

Note: The summation of throughput classes of all virtual calls, permanent virtual circuits and datagram logical channels supported at a DTE/DCE interface may be greater than the data transmission rate of the access line.

4.4.3 Procedure for Reset

The reset procedure is used to re-initialize the virtual call or permanent virtual circuit and in so doing removes in each direction all data and interrupt packets which may be in the network (see section 4.5). When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent data packets to cross the DTE/DCE interface for each direction of data transmission shall start from 0.

The reset procedure can only apply in the DATA TRANSFER state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a clearing or restarting procedure is initiated, RESET REQUEST and RESET INDICATION packets can be left unconfirmed.

For flow control, there are three states d1, d2 and d3 within the DATA TRANSFER state (p4). They are FLOW CONTROL READY (d1), DTE RESET REQUEST (d2), and DCE RESET INDICATION (d3) as shown in the state diagram in Annex 2, Figure A2.3/X.25. When entering state p4, the logical channel is placed in state d1. Annex 3, Table A3.4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

4.4.3.1 Reset Request Packet

The DTE shall indicate a request for reset by transmitting a RESET REQUEST packet specifying the logical channel. This places the logical channel in the DTE RESET REQUEST state (d2).

4.4.3.2 Reset Indication Packet

The DCE shall indicate a reset by transmitting to the DTE a RESET INDICATION packet specifying the logical channel and the reason for the resetting. This places the logical channel in the DCE RESET INDICATION state (d3). In this state, the DCE will ignore data, interrupt, RR and RNR packets.

4.4.3.3 Reset Collision

Reset collision occurs when a DTE and a DCE simultaneously transmit a RESET REQUEST packet and a RESET INDICATION packet specifying the same logical channel. Under this circumstance the DCE will consider that the reset is completed. The DCE will not expect a DTE RESET CONFIRMATION packet and will not transfer a DCE RESET CONFIRMATION packet. This places the logical channel in the FLOW CONTROL READY state (d1).

4.4.3.4 Reset Confirmation Packets

When the logical channel is in the DTE RESET REQUEST state (d2), the DCE will confirm reset by transmitting to the DTE a DCE RESET CONFIRMATION packet. This places the logical channel in the FLOW CONTROL READY state (d1).

The DCE RESET CONFIRMATION packet can only be interpreted universally as having local significance, however within some Administration's networks reset confirmation may have end to end significance. In all cases the time spent in the DTE RESET REQUEST state (d2) will not exceed time-limit T22 (see Annex 4).

When the logical channel is in the DCE RESET INDICATION state (d3), the DTE will confirm reset by transmitting to the DCE a DTE RESET CONFIRMATION packet. This places the logical channel in the FLOW CONTROL READY state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 is given in Annex 4.

4.5 Effects of Clear, Reset and Restart Procedures on the Transfer of Packets

All data and interrupt packets generated by a DTE (or the network) before initiation by the DTE or the DCE of a clear, reset or restart procedure at the local interface will either be delivered to the remote DTE before the DCE transmits the corresponding indication on the remote interface, or be discarded by the network.

No data or interrupt packets generated by a DTE (or the network) after the completion of a reset (or for permanent virtual circuits also a restart) procedure at the local interface will be delivered to the remote DTE before the completion of the corresponding reset procedure at the remote interface.

When a DTE initiates a clear, reset or restart procedure on its local interface, all data and interrupt packets which were generated by the remote DTE (or the network) before the corresponding indication is transmitted to the remote DTE will be either delivered to the initiating DTE before DCE confirmation of the initial clear, reset or restart request, or be discarded by the network.

Note: The maximum number of packets which may be discarded is a function of network end-to-end delay and throughput characteristics and, in general, has no relation to the local window size. Provision of more precise information is for further study. For virtual calls and permanent virtual circuits on which all data packets are transferred with the D bit set to 1, the maximum number of packets which may be discarded in one direction of transmission is not larger than the window size of the direction of

transmission.

4.6 Effects of Physical and Link Level Failures

When a failure on the physical and/or link level is detected, the DCE will transmit to the remote end:

(1) a reset with the cause "Out of order" for each permanent virtual circuit and

(2) a clear with the cause "Out of order" for each existing virtual call.

During the failure, the DCE will clear any incoming virtual calls.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned (see section 3.5) and a reset with the cause "Remote DTE operational" will be transmitted to the remote end of each permanent virtual circuit.

5. PROCEDURES FOR DATAGRAM SERVICE

Annex 2 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel. Figures A2.1/X.25 and A2.3/X.25 apply to datagram logical channels.

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 2. Details of actions which should be taken by the DTE are for further study.

There is no call set-up or clearing for datagrams.

A DTE DATAGRAM packet includes the destination DTE address; the source DTE address may also be used.

A DCE DATAGRAM packet includes the source DTE address; the destination DTE address may also be used.

Note: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

5.1 Procedures for Datagram Transfer

The data transfer procedure applies independently to each datagram logical channel existing at the DTE/DCE interface.

Normal network operation dictates that user data in datagram packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications.

Order of bits of user data is preserved within a datagram.

5.1.1 States for Data Transfer

Datagram logical channels are continually in the DATA TRANSFER state (p4) except during the restart procedure. Datagram, datagram service signal, flow control, and reset packets may be transmitted and received by a DTE in the DATA TRANSFER state of a datagram logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in section 5.2 apply to data transmission on that datagram logical channel to and from the DTE.

5.1.2 User Data Field Length

The maximum User Data field length for datagrams is 128 octets.

The data field of datagram packets transmitted by a DTE or DCE may contain any number of bits up to the maximum.

Note: At present, some networks require the data field to contain an integral number of octets (see section 3, Note 2).

5.1.3 Datagram Identification

Each datagram transmitted at the DTE/DCE interface for each direction of transmission may be uniquely numbered with a datagram identification number. Assignment of the values to the datagram identification is a DTE responsibility and may be assigned according to any algorithm. The network will not operate on the datagram identification except to return the information in the appropriate network generated datagram service signal packet.

5.1.4 Datagram Service Signals

The DCE will be capable of transferring to the DTE service signals as specified in Recommendation X.96. The datagram service signals will be carried in datagram service signal packets. Datagram service signals are of two types - specific and general.

5.1.4.1 Datagram Service Signal - Specific

This is a service signal generated by the network relative to a specific datagram issued by the DTE. There are three classes for this type of service signal:

(a) Datagram rejected - datagram discarded by network; a correction, based on the received cause, is required before trying again.

(b) Datagram non-delivery indication - datagram discarded by network; try again later based on the received

cause, next time may be successful.

Note: This class of service signal is only issued by the network when the non-delivery indication facility (see section 7.3.4) has been requested.

(c) Datagram delivery confirmation - datagram has been accepted by the destination DTE.

Note: This class of service signal is only issued by the network when the delivery confirmation facility (see section 7.3.5) has been requested.

Datagram service signal - specific packets will include the address information, if valid, and the datagram identification associated with the original datagram for which the service signal applies. The original destination address is provided in the datagram service signal packet as the source address while the original source address is shown as the destination address, when present.

5.1.4.2 Datagram Service Signal - General

This is a service signal generated by the network relative to datagram operation but not to any specific datagram issued by the DTE.

5.2 Procedures for Flow Control

This subsection only applies to the DATA TRANSFER state (p4) and specifies the procedures covering flow control of datagram and datagram service signal packets and reset on each datagram logical channel.

5.2.1 Flow Control

At the DTE/DCE interface of a datagram logical channel, the transmission of datagram and datagram service signal packets is controlled separately for each direction and is based on authorizations from the receiver. Datagram and datagram service signal packets are referred to below as flow controlled packets.

5.2.1.1 Numbering of Packets

Each datagram and datagram service signal packet transmitted at the DTE/DCE interface for each direction of transmission on a given datagram logical channel is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. Some Administrations will provide the Extended Packet Sequence Numbering facility (see section 7.1.1) which, if selected, provides a sequence numbering scheme for packets being

[illegible] 128. In this case, packet sequence numbers [illegible] entire range 0 to 127. The packet sequence [illegible] scheme, modulo 8 or 128, is the same for both direc- [illegible] transmission and is common for all logical channels at [illegible] interface.

[illegible] service, only datagram and datagram service signal [illegible] in this sequence number called the packet send [illegible].

[illegible] first datagram or datagram service signal packet to be transmitted across the DTE/DCE interface for a given direction of [illegible] transmission, when the datagram logical channel has just [illegible] CONTROL READY state (d1), has a packet send [illegible] number equal to 0.

[illegible] Window Description

[illegible] interface of a datagram logical channel, and for [illegible] of data transmission, a window is defined as the [illegible] consecutive packet send sequence numbers of the [illegible] packets authorized to cross the interface.

[illegible] number in the window is referred to as the [illegible]. When the datagram logical channel has just [illegible] CONTROL READY state (d1), the window related to [illegible] data transmission has a lower window edge equal

[illegible] sequence number of the first flow controlled [illegible] authorized to cross the interface is the value of the [illegible] edge plus W (modulo 8, or 128 when extended).

[illegible] window size W is 2 for each direction of data [illegible] at a DTE/DCE interface. In addition, other window [illegible] be offered by Administrations and may be selected for a [illegible] time for each datagram logical channel (see section

[illegible] Flow Control Principles

[illegible] sequence number of the next flow controlled packet to be [illegible] by the DCE is within the window, the DCE is author- [illegible] transmit this flow controlled packet to the DTE. When [illegible] number P(S) of the next flow controlled packet to be [illegible] by the DCE is outside of the window, the DCE shall [illegible] transmit a flow controlled packet to the DTE. The DTE should follow the same procedure.

When the sequence number P(S) of the flow controlled packet [illegible] by the DCE is the next in sequence and is within the window, the DCE will accept this flow controlled packet. A [illegible] flow controlled packet containing a P(S) that is out of

sequence (i.e., there is a duplicate or a gap in the P(S) numbering), outside the window, or not equal to zero for the first flow controlled packet after entering the FLOW CONTROL READY state (d1) is considered by the DCE as a local procedure error. The DCE will reset the datagram logical channel (see section 5.2.3). The DTE should follow the same procedure.

A number (modulo 8, or 128 when extended), referred to as a packet receive sequence number P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of flow controlled packets. When transmitted across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional flow controlled packets may be authorized by the receiver to cross the DTE/DCE interface.

The packet receive sequence number, P(R), is conveyed in datagram, datagram service signal, receive ready (RR) and receive not ready (RNR) packets.

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE up to and including the packet send sequence number of the next flow controlled packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the logical channel. The DTE should follow the same procedure.

The receive sequence number P(R) is less than or equal to the sequence number of the next expected flow controlled packet and implies that the DTE or DCE transmitting P(R) has accepted <u>at least</u> all flow controlled packets numbered up to and including P(R)-1.

The only significance of a P(R) value is a local updating of the window across the packet level interface.

5.2.1.4 <u>Datagram Queue</u>

The network maintains a datagram queue for each datagram logical channel at destination DCE. The maximum length of the queue for each datagram logical channel is agreed for a period of time between the DTE and the Administration (see section 7.3.2).

Datagram service signal packets have priority over other datagram packets and are inserted at the beginning of the queue. This may lead to the DCE discarding the last datagram packet of the queue if the maximum queue length is exceeded. When the queue is full, additional arriving datagrams are discarded.

By agreement for a period of time between the DTE and the Administration (see section 7.3.3), a special datagram logical channel may be assigned for the transmission of datagram service signals. In this case, the maximum length of the queues for datagrams and datagram service signals are independently agreed

between the DTE and the Administration.

If the DTE flow controls the receipt of datagram service signal packets, the DCE cannot guarantee to store an indefinite number of service signals. Therefore, there is a possibility of loss of service signal packets at the DCE. A possible coupling mechanism to allow the DCE to regulate the number of datagrams generated by the DTE in relation to the capacity of the DCE to store the datagram service signals will be studied to determine whether such losses at the DCE should be prevented.

5.2.1.5 DTE and DCE Receive Ready (RR) Packets

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W flow controlled packets within the window starting with P(R), where P(R) is indicated in the RR packet.

5.2.1.6 DTE and DCE Receive Not Ready (RNR) Packets

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional flow controlled packets for a given datagram logical channel. A DTE or DCE receiving an RNR packet shall stop transmitting flow controlled packets on the indicated datagram logical channel, but the window is updated by the P(R) value of the RNR packet. The receive not ready situation indicated by the transmission of RNR packet is cleared by the transmission in the same direction of an RR packet or by a reset procedure being initiated.

The transmission of an RR after an RNR at the packet level is not to be taken as a demand for retransmission of packets which have already been transmitted.

5.2.2 Throughput Characteristics

Throughput is the effective data transfer rate measured in bits per second.

For each datagram logical channel, a throughput class for each direction of data transmission at the DTE/DCE interface is agreed for a period of time between the DTE and the Administration (see section 7.1.3).

Relating to datagram operation, the following has been identified for further study:

(a) The attainment of throughput on a given datagram logical channel.

(b) The necessity for discriminating between throughput on datagram logical channels compared with logical channels used for virtual calls and permanent virtual circuits.

5.2.3 Procedure for Reset

The reset procedure is used to re-initialize the datagram logical channel. When a datagram logical channel at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent flow controlled packets to cross the DTE/DCE interface for each direction of data transmission shall start from 0.

For datagram logical channels, the reset procedure causes datagrams and datagram service signals to be purged from the DCE queue associated with that datagram logical channel. A datagram service signal with the cause "Remote procedure error" will be issued to the remote end for each datagram requesting the non-delivery indication facility.

The reset procedure can only apply in the DATA TRANSFER state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a restarting procedure is initiated, RESET REQUEST and RESET INDICATION packets can be left unconfirmed.

For flow control, there are three states d1, d2, and d3 within the DATA TRANSFER state (p4). They are FLOW CONTROL READY (d1), DTE RESET REQUEST (d2), and DCE RESET INDICATION (d3) as shown in the state diagram in Annex 2, Figure A2.3/X.25. When entering state p4, the datagram logical channel is placed in state d1. Annex 3, Table A3.4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

5.2.3.1 Reset Request Packet

The DTE shall indicate a request for reset by transmitting a RESET REQUEST packet specifying the datagram logical channel. This places the datagram logical channel in the DTE RESET REQUEST state (d2).

5.2.3.2 Reset Indication Packet

The DCE shall indicate a reset by transmitting to the DTE a RESET INDICATION packet specifying the datagram logical channel and the reason for the resetting. This places the datagram logical channel in the DCE RESET INDICATION state (d3). In this state, the DCE will ignore datagram, RR and RNR packets.

5.2.3.3 Reset Collision

Reset collision occurs when a DTE and a DCE simultaneously transmit a RESET REQUEST packet and a RESET INDICATION packet specifying the same datagram logical channel. Under this circumstance, the DCE will consider the reset completed. The DCE will not expect a DTE RESET CONFIRMATION packet and will not

transfer a DCE RESET CONFIRMATION packet. This places the datagram logical channel in the FLOW CONTROL READY state (d1).

5.2.3.4 Reset Confirmation Packets

When the datagram logical channel is in the DTE RESET REQUEST state (d2), the DCE will confirm reset by transmitting to the DTE a DCE RESET CONFIRMATION packet. This places the datagram logical channel in the FLOW CONTROL READY state (d1).

The DCE RESET CONFIRMATION packet has local significance. The time spent in the DTE RESET REQUEST state (d2) will not exceed time-limit T22 (see Annex 4).

When the datagram logical channel is in the DCE RESET INDICATION state, the DTE will confirm reset by transmitting to the DCE a DTE RESET CONFIRMATION packet. This places the datagram logical channel in the FLOW CONTROL READY state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 is given in Annex 4.

5.3 Effects of Reset and Restart Procedures on the Transfer of Packets

For datagram logical channels, the reset and restart procedures cause datagrams and datagram service signals to be purged from the DCE queue. A datagram service signal with the cause "Remote procedure error" will be issued to the remote end for each datagram requesting the non-delivery indication facility.

5.4 Effects of Physical and Link Level Failures

When a failure on physical and/or link level is detected, the DCE will purge datagrams and datagram service signals from the DCE queue associated with each datagram logical channel and, for each datagram requesting the non-delivery indication facility, transmit to the remote end a datagram service signal with the cause "Out of order".

During the failure, the DCE will discard any incoming datagrams and datagram service signals. A datagram service signal with the cause "Out of order" will be sent to the remote end for each datagram requesting the non-delivery indication facility.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned (see section 3.5). Upon completion of this procedure, incoming datagrams and datagram service signals will be handled in the normal manner.

6. PACKET FORMATS

6.1 General

The possible extension of packet formats by the addition of new fields is for further study.

Note: Any such field:

(a) would only be provided as an addition following all previously defined fields, and not as an insertion between any of the previously defined fields.

(b) would be transmitted to a DTE only when either the DCE has been informed that the DTE is able to interpret this field and act upon it, or when the DTE can ignore the field without adversely affecting the operation of the DCE.

(c) would not contain any information pertaining to a user facility to which the DTE has not subscribed.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.

6.1.1 General Format Identifier

The General Format Identifier field is a four bit binary coded field which is provided to indicate the general format of the rest of the header. The General Format Identifier field is located in bit positions 8, 7, 6 and 5 of octet 1, and bit 5 is the low order bit (see Table 6.1/X.25).

TABLE 6.1/X.25

GENERAL FORMAT IDENTIFIER

GENERAL FORMAT IDENTIFIER		Octet 1 bits 8 7 6 5
Call set-up packets	Sequence numbering scheme modulo 8	0 X 0 1
	Sequence numbering scheme modulo 128	0 X 1 0
Clearing, datagram, flow control, interrupt, reset, restart and diagnostic packets	Sequence numbering scheme modulo 8	0 0 0 1
	Sequence numbering scheme modulo 128	0 0 1 0
Data packets	Sequence numbering scheme modulo 8	X X 0 1
	Sequence numbering scheme modulo 128	X X 1 0
Datagram service signal packets	Sequence numbering scheme modulo 8	1 0 0 1
	Sequence numbering scheme modulo 128	1 0 1 0
General Format Identifier extension		* * 1 1

*Undefined

Note: A bit which is indicated as "X" may be set to either "0" or "1" as discussed in subsequent sections.

Bit 8 of the General Format Identifier is used for the Qualifier bit in data packets. It is set to 1 in datagram service signal packets and is set to 0 in all other packets.

Bit 7 of the General Format Identifier is used for the delivery confirmation procedure in data and call set-up packets and is set to 0 in all other packets.

Bits 6 and 5 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering from packets using modulo 128 sequence numbering. The third code is used to indicate an extension to an expanded format

for a family of General Format Identifier codes which are a subject of further study. The fourth code is unassigned.

Note 1: In the absence of the Extended Packet Sequence Numbering facility (see section 7.1.1), the sequence numbering scheme is performed modulo 8.

Note 2: It is envisaged that other General Format Identifier codes could identify alternative packet formats.

6.1.2 Logical Channel Group Number

The Logical Channel Group Number appears in every packet except restart packets and diagnostic packets in bit positions 4, 3, 2 and 1 of octet 1. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the Logical Channel Group Number. In restart and diagnostic packets, this field is coded all zeros.

6.1.3 Logical Channel Number

The Logical Channel Number appears in every packet except restart packets and diagnostic packets in all bit positions of octet 2. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the Logical Channel Number. In restart and diagnostic packets, this field is coded all zeros.

6.1.4 Packet Type Identifier

Each packet shall be identified in octet 3 of the packet according to Table 6.2/X.25.

TABLE 6.2/X.25

PACKET TYPE IDENTIFIER

PACKET TYPE: FROM DCE TO DTE	PACKET TYPE: FROM DTE TO DCE	OCTET 3 BITS 8	7	6	5	4	3	2	1
CALL SET-UP AND CLEARING									
INCOMING CALL	CALL REQUEST	0	0	0	0	1	0	1	1
CALL CONNECTED	CALL ACCEPTED	0	0	0	0	1	1	1	1
CLEAR INDICATION	CLEAR REQUEST	0	0	0	1	0	0	1	1
DCE CLEAR CONFIRMATION	DTE CLEAR CONFIRMATION	0	0	0	1	0	1	1	1
DATA AND INTERRUPT									
DCE DATA	DTE DATA	X	X	X	X	X	X	X	0
DCE INTERRUPT	DTE INTERRUPT	0	0	1	0	0	0	1	1
DCE INTERRUPT CONFIRMATION	DTE INTERRUPT CONFIRMATION	0	0	1	0	0	1	1	1
DATAGRAM*									
DCE DATAGRAM	DTE DATAGRAM	X	X	X	X	X	X	X	0
DATAGRAM SERVICE SIGNAL		X	X	X	X	X	X	X	0
FLOW CONTROL AND RESET									
DCE RR (MODULO 8)	DTE RR (MODULE 8)	X	X	X	0	0	0	0	1
DCE RR (MODULO 128)*	DTE RR (MODULO 128)*	0	0	0	0	0	0	0	1
DCE RNR (MODULO 8)	DTE RNR (MODULO 8)	X	X	X	0	0	1	0	1
DCE RNR (MODULO 128)*	DTE RNR (MODULO 128)*	0	0	0	0	0	1	0	1
	DTE REJ (MODULO 8)*	X	X	X	0	1	0	0	1
	DTE REJ (MODULO 128)*	0	0	0	0	1	0	0	1
RESET INDICATION	RESET REQUEST	0	0	0	1	1	0	1	1
DCE RESET CONFIRMATION	DTE RESET CONFIRMATION	0	0	0	1	1	1	1	1
RESTART									
RESTART INDICATION	RESTART REQUEST	1	1	1	1	1	0	1	1
DCE RESTART CONFIRMATION	DTE RESTART CONFIRMATION	1	1	1	1	1	1	1	1
DIAGNOSTIC									
DIAGNOSTIC*		1	1	1	1	0	0	0	1

* Not necessarily available on every network.

Note: A bit which is indicated as "X" may be set to either "0" or "1" as discussed in subsequent sections.

6.2 Call Set-Up and Clearing Packets

6.2.1 Call Request and Incoming Call Packets

Figure 6.1/X.25 illustrates the format of CALL REQUEST and INCOMING CALL packets.

General Format Identifier

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in section 4.3.3 is used.

Address Lengths Field

Octet 4 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Address Field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

	Bits 8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	0	1	0	1	1
4	Calling DTE address length				Called DTE address length			
	DTE Address (See Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Call User Data (See Notes 3 and 4)							

<u>Note 1</u>: Coded 0X01 (modulo 8) or 0X10 (modulo 128).
<u>Note 2</u>: The figure is drawn assuming a single address is present consisting of an odd number of digits.
<u>Note 3</u>: Bits 8 and 7 of the first octet of the Call User Data field may have particular significance (see section 6.2.1).
<u>Note 4</u>: Maximum length of the Call User Data field is 16 octets.

Figure 6.1/X.25 - Call request and incoming call packet format

Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in the CALL REQUEST and INCOMING CALL packets.

The coding of the Facility field is defined in section 7.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 63 octets.

Call User Data Field

Following the Facility field, the Call User Data field may be present and has a maximum length of 16 octets.

Note: At present, some networks require the Call User Data field to contain an integral number of octets (see section 3, Note 2).

If the Call User Data field is present, the use and format of this field is determined by bits 8 and 7 of the first octet of this field (see Note).

If bits 8 and 7 of the first octet of the Call User Data field are 00, a portion of the Call User Data field is used for protocol identification in accordance with other CCITT Recommendations such as Recommendation X.29.

If bits 8 and 7 of the first octet of the Call User Data field are 01, a portion of the Call User Data field may be used for protocol identification in accordance with specifications of Administrations.

If bits 8 and 7 of the first octet of the Call User Data field are 10, a portion of the Call User Data field may be used for protocol identification in accordance with specifications of international user bodies.

If bits 8 and 7 of the first octet of the Call User Data field are 11, no constraints are placed on the use by the DTE of the remainder of the Call User Data field.

Users are cautioned that if bits 8 and 7 of the first octet of the Call User Data field have any value other than 11, a protocol may be identified that is implemented within public data networks.

Note: When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the Call User Data field, unless required to do otherwise by an

appropriate request for an optional user facility on a per call basis. Such a facility is for further study.

6.2.2 Call Accepted and Call Connected Packets

Figure 6.2/X.25 illustrates the format of CALL ACCEPTED and CALL CONNECTED packets.

General Format Identifier

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in section 4.3.3 is used.

Address Lengths Field

Octet 4 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

The use of the Address Lengths field in CALL ACCEPTED packets is only mandatory when the Address field or the Facility Length field is present.

Address Field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	0	1	1	1	1
4	Calling DTE address length*				Called DTE address length*			
	DTE Address (See Note 2)*							
					0	0	0	0
	0	0	Facility length*					
	Facilities*							

Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.

* These fields are not mandatory in CALL ACCEPTED packets (see section 6.2.2).

Figure 6.2/X.25 - Call accepted and call connected packet format

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

The use of the Facility Length field in CALL ACCEPTED packets is only mandatory when the Facility field is present.

Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in the CALL ACCEPTED and CALL CONNECTED packets.

The coding of the Facility field is defined in section 7.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 63 octets.

6.2.3 Clear Request and Clear Indication Packets

Figure 6.3/X.25 illustrates the format of CLEAR REQUEST and CLEAR INDICATION packets.

Clearing Cause Field

Octet 4 is the Clearing Cause field and contains the reason for the clearing of the call.

The bits of the Clearing Cause field in CLEAR REQUEST packets should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

The coding of the Clearing Cause field in CLEAR INDICATION packets is given in Table 6.3/X.25.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	1	0	0	1	1
4	Clearing Cause							
5	Diagnostic Code*							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

* This field is not mandatory in CLEAR REQUEST packets.

Figure 6.3/X.25 - **Clear request and clear indication packet format**

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	1	0	1	1	1

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.4/X.25- **DTE and DCE clear confirmation packet format**

TABLE 6.3/X.25

CODING OF CLEARING CAUSE FIELD IN CLEAR INDICATION PACKET

	8	7	6	5	4	3	2	1
DTE originated	0	0	0	0	0	0	0	0
Number busy	0	0	0	0	0	0	0	1
Out of order	0	0	0	0	1	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Reverse charging acceptance not subscribed*	0	0	0	1	1	0	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Fast select acceptance not subscribed*	0	0	1	0	1	0	0	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Local procedure error	0	0	0	1	0	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1
RPOA out of order*	0	0	0	1	0	1	0	1

* May be received only if the corresponding optional user facility is used.

Diagnostic Code

Octet 5 is the Diagnostic Code and contains additional information on the reason for the clearing of the call.

In a CLEAR REQUEST packet, the Diagnostic Code is not mandatory.

In a CLEAR INDICATION packet, if the Clearing Cause field indicates "DTE originated," the Diagnostic Code is passed unchanged from the clearing DTE. If the clearing DTE has not provided a Diagnostic Code in its CLEAR REQUEST packet, then the bits of the Diagnostic Code in the resulting CLEAR INDICATION packet will all be zero.

When a CLEAR INDICATION packet results from a RESTART REQUEST packet, the value of the Diagnostic Code will be that specified in the RESTART REQUEST packet, or all zeros in the case where no Diagnostic Code has been specified in RESTART REQUEST.

When the Clearing Cause field does not indicate "DTE originated," the Diagnostic Code in a CLEAR INDICATION packet is network generated. Annex 5 lists the codings for network generated

diagnostics. The bits of the Diagnostic Code are all set to 0 when no specific additional information for the clearing is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

6.2.4 DTE and DCE Clear Confirmation Packets

Figure 6.4/X.25 illustrates the format of the DTE and DCE CLEAR CONFIRMATION packets.

6.3 Data and Interrupt Packets

6.3.1 DTE and DCE Data Packets

Figure 6.5/X.25 illustrates the format of the DTE and DCE DATA packets.

Qualifier Bit

Bit 8 of octet 1 is the Qualifier bit.

Delivery Confirmation Bit

Bit 7 of octet 1 is the Delivery Confirmation bit.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3 or bits 8 through 2 of octet 4, when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

More Data Bit

Bit 5 in octet 3, or bit 1 in octet 4 when extended, is used for the More Data mark: 0 for no more data and 1 for more data.

Packet Send Sequence Number

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier Q	D	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			M	P(S)			0
	User Data							

(Modulo 8)

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier Q	D	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	P(S)							0
4	P(R)							M
	User Data							

(When extended to modulo 128)

D = Delivery Confirmation bit

M = More Data bit

Q = Qualifier bit

Figure [illegible]. - DTE and DCE data packet format

User Data Field

Bits following octet 3, or octet 4 when extended, contain user data.

Note: At present, some networks require the User Data field to contain an integral number of octets (see section 3, Note 2).

6.3.2 DTE and DCE Interrupt Packets

Figure 6.6/X.25 illustrates the format of the DTE and DCE INTERRUPT packets.

Interrupt User Data Field

Octet 4 contains user data.

6.3.3 DTE and DCE Interrupt Confirmation Packets

Figure 6.7/X.25 illustrates the format of the DTE and DCE INTERRUPT CONFIRMATION packets.

6.4 Datagram and Datagram Service Signal Packets

6.4.1 DTE and DCE Datagram Packets

Figure 6.8/X.25 illustrates the format of DTE and DCE DATAGRAM packets.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

Packet Send Sequence Number

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Address Lengths Field

The octet following the sequence numbers consists of field length indicators for the destination and source DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the destination DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the source DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	1	0	0	0	1	1
4	Interrupt User Data							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.6/X.25 - DTE and DCE interrupt packet format

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	1	0	0	1	1	1

Note: coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.7/X.25 - DTE and DCE interrupt confirmation packet format

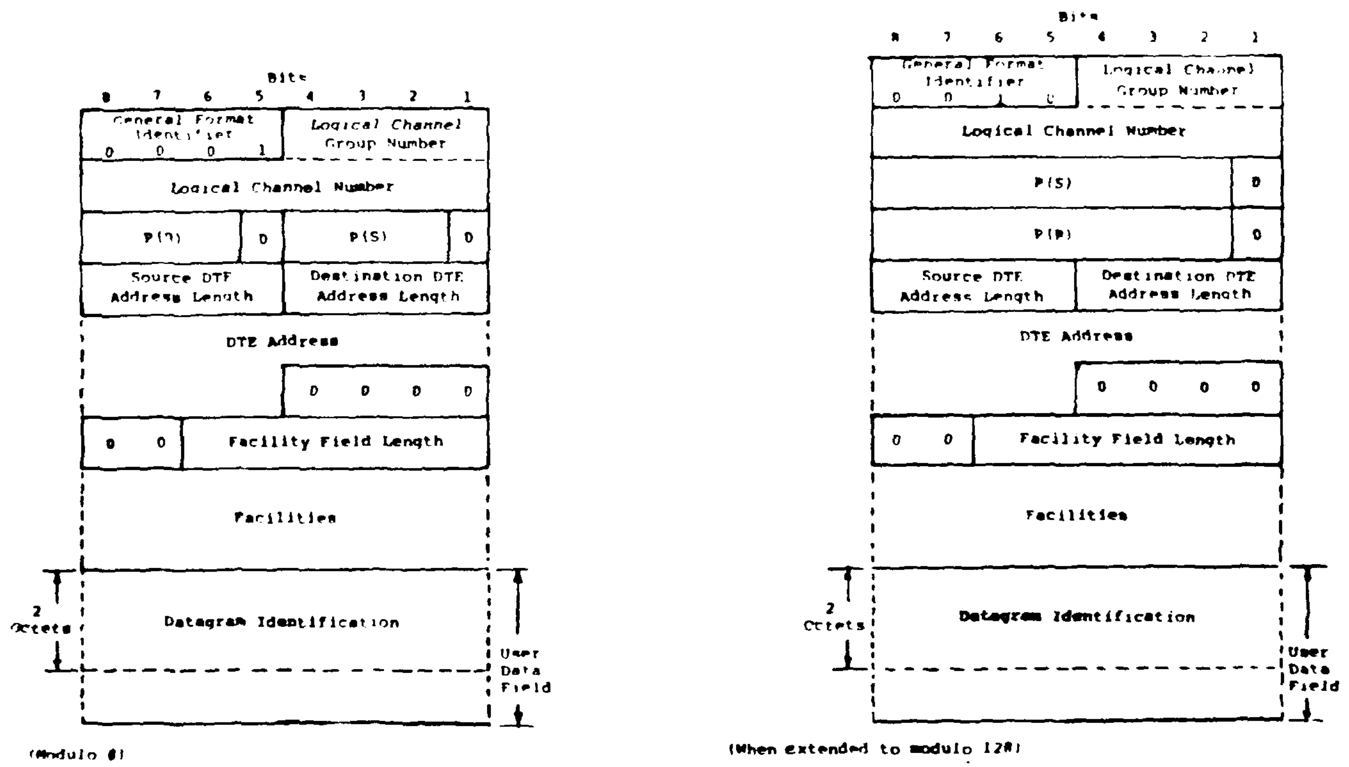


Figure 6.8/X.25 - DTE and DCE datagram packet format

Address Field

The octets following the Address Length field consist of the destination DTE address when present, then the source DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in the datagram packet.

The coding of this Facility field is defined in section 7.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However this maximum does not exceed 63 octets.

User Data Field

Following the Facility field, the User Data field may be present and has a maximum length of 128 octets. The first two octets of the User Data field are called the datagram identification.

Note: At present, some networks require the User Data field to contain an integral number of octets (see section 3, Note 2).

6.4.2 Datagram Service Signal Packets

Figure 6.9/X.25 illustrates the format of DATAGRAM SERVICE SIGNAL packets.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

Packet Send Sequence Number

Bit 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Address Lengths Field

The octet following the sequence numbers consists of field length indicators for the destination and source DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the destination DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the source DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

The source DTE address length indicator is coded all zeros for datagram service signal - general packets.

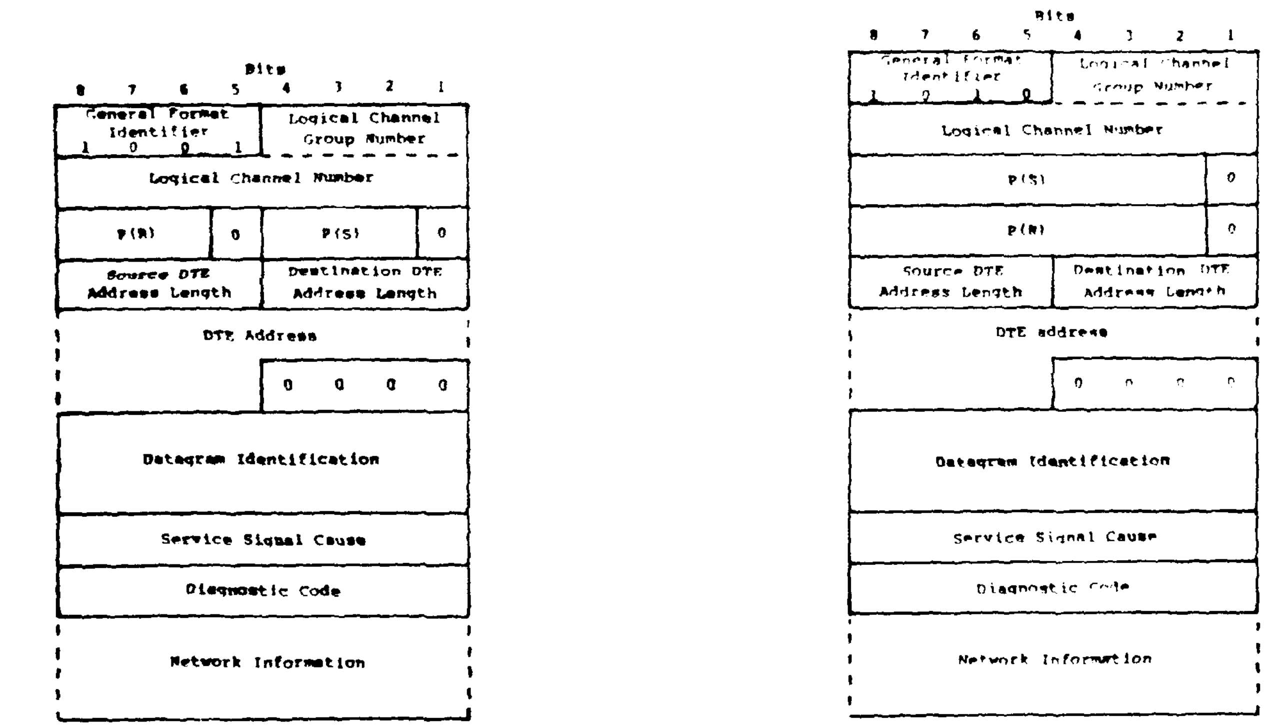
Address Field

The octets following the Address Length field consist of the destination DTE address when present, then the source DTE address when present (see section 5.1.4.1).

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.



(Modulo 8)

(When extended to modulo 128)

Figure 6.9/X.25 – Datagram service signal packet format

Datagram Identification Field

The Datagram Identification field of datagram service signal - specific packets contains the first two octets of the User Data field from the original datagram to which the datagram service signal packet applies. If the User Data field of the original datagram is less than two octets, the Datagram Identification field in the datagram service signal packet will be padded out to two octets by inserting the appropriate number of 0 bits.

The Datagram Identification field of datagram service signal - general packets is coded with all zeros.

Cause Field

The octet immediately following the Datagram Identification field is the Cause field and contains the reason for the datagram service signal.

The coding of the Cause field is given in Table 6.4/X.25.

TABLE 6.4/X.25

CODING OF CAUSE FIELD IN DATAGRAM SERVICE SIGNAL PACKET

	8	7	6	5	4	3	2	1
Datagram Service Signal - Specific								
Datagram Rejected								
Local procedure error	0	0	0	1	0	0	1	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Not obtainable	0	0	0	0	1	1	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Reverse charging acceptance not subscribed	0	0	0	1	1	0	0	1
Datagram Non-Delivery Indication (Note 1)								
Network congestion	0	0	0	0	0	1	0	1
Out of order	0	0	0	0	1	0	0	1
Number busy (destination queue full)	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Datagram Delivery Confirmation (Note 2)								
Delivery confirmation	0	0	1	1	0	0	0	1
Datagram Service Signal - General								
Local DCE queue overflow (Note 3)	0	1	1	1	1	1	1	1
Network congestion	0	1	0	0	0	1	1	1
Network operational	0	1	0	0	1	1	1	1

Note 1: Issued only when the Non-delivery Indication facility (see section 7.3.4) has been requested.

Note 2: Issued only when the Delivery Confirmation facility (see section 7.3.5) has been requested.

Note 3: For further study.

Diagnostic Code

The octet immediately following the Cause field contains additional information on the reason for the datagram service signal.

The coding of the Diagnostic Code field is given in Annex 5. Assigned Diagnostic Codes applicable to datagram service signal packets include decimal 33, 38, 39, 40, 65, 66, 67 and 68. The bits of the Diagnostic Code in a datagram service signal packet are all set to zero when no specific additional information for the service signal is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

Network Information Field

Following the Diagnostic Code field, the Network Information field may be present and has a maximum length of 16 octets.

If the Diagnostic Code field designates Facility Code Not Allowed or Facility Parameter Not Allowed, then the Network Information field will contain the octets associated with the facility code and its associated parameter field. If the Diagnostic Code field designates Invalid Address, then the Network Information Field will contain the octets associated with the two Address Length fields and the octets associated with the Address field.

The information content of this field for other Diagnostic Codes is for further study.

6.5 Flow Control and Reset Packets

6.5.1 DTE and DCE Receive Ready (RR) Packets

Figure 6.10/X.25 illustrates the format of the DTE and DCE RR packets.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.5.2 DTE and DCE Receive Not Ready (RNR) Packets

Figure 6.11/X.25 illustrates the format of the DTE and DCE RNR packets.

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier 0	0	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			Packet Type Identifier 0	0	0	0	1

(Modulo 8)

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier 0	0	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	0	0	0	1
4	P(R)							0

(when extended to Modulo 128)

Figure 6.10/X.25 - DTE and DCE RR packet format

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier 0	0	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			Packet Type Identifier 0	0	1	0	1

(Modulo 8)

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier 0	0	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	0	1	0	1
4	P(R)							0

(when extended to Modulo 128)

Figure 6.11/X.25 - DTE and DCE RNR packet format

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.5.3 Reset Request and Reset Indication Packets

Figure 6.12/X.25 illustrates the format of the RESET REQUEST and RESET INDICATION packets.

Resetting Cause Field

Octet 4 is the Resetting Cause field and contains the reason for the reset.

The bits of the Resetting Cause field in a RESET REQUEST packet should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

The coding of the Resetting Cause field in a RESET INDICATION packet is given in Table 6.5/X.25.

TABLE 6.5/X.25

CODING OF RESETTING CAUSE FIELD IN RESET INDICATION PACKET

	8	7	6	5	4	3	2	1
DTE originated**	0	0	0	0	0	0	0	0
Out of order*	0	0	0	0	0	0	0	1
Remote procedure error**	0	0	0	0	0	0	1	1
Local procedure error	0	0	0	0	0	1	0	1
Network congestion	0	0	0	0	0	1	1	1
Remote DTE operational*	0	0	0	0	1	0	0	1
Network operational***	0	0	0	0	1	1	1	1
Incompatible destination**	0	0	0	1	0	0	0	1

* Applicable to permanent virtual circuits only.

** Applicable to virtual calls and permanent virtual circuits only.

*** Applicable to permanent virtual circuits and datagram logical channels only.

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Octet	8	7	6	5	4	3	2	1
1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	1	1	0	1	1
4	Resetting Cause							
5	Diagnostic Code*							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

* This field is not mandatory in RESET REQUEST packets.

Figure 6.12/X.25 - Reset request and reset indication packet format

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	1	1	1	1	1

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.13/X.25 - DTE and DCE reset confirmation packet format

Diagnostic Code

Octet 5 is the Diagnostic Code and contains additional information on the reason for the reset.

In a RESET REQUEST packet the Diagnostic code is not mandatory.

In a RESET INDICATION packet, if the Resetting Cause field indicates "DTE originated," the Diagnostic Code has been passed unchanged from the resetting DTE. If the DTE requesting a reset has not provided a Diagnostic Code in its RESET REQUEST packet, then the bits of the Diagnostic Code in the resulting RESET INDICATION packet will all be zeros.

If a RESET INDICATION packet results from a RESTART REQUEST packet, the value of the Diagnostic Code will be that specified in the RESTART REQUEST, or all zeros in the case where no Diagnostic Code has been specified in RESTART REQUEST.

If the Resetting Cause field does not indicate "DTE originated", the Diagnostic Code in a RESET INDICATION packet is network generated. Annex 5 lists the codings for network generated diagnostics. The bits of the Diagnostic Code are all set to 0 when no specific additional information for the reset is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

6.5.4 DTE and DCE Reset Confirmation Packets

Figure 6.13/X.25 illustrates the format of the DTE and DCE RESET CONFIRMATION packets.

6.6 Restart Packets

6.6.1 Restart Request and Restart Indication Packets

Figure 6.14/X.25 illustrates the format of the RESTART REQUEST and RESTART INDICATION packets.

Restarting Cause Field

Octet 4 is the Restarting Cause field and contains the reason for the restart.

The bits of the Restarting Cause field in RESTART REQUEST packets should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier See Note				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet Type Identifier							
	1	1	1	1	1	0	1	1
4	Restarting Cause							
5	Diagnostic Code*							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

* This field is not mandatory in RESTART REQUEST packets

Figure 6.14/X.25 - Restart request and restart indication packet format

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier See Note				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet Type Identifier							
	1	1	1	1	1	1	1	1

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.15/X.25 - DTE and DCE restart confirmation packet format

The coding of the Restarting Cause field in the RESTART INDICATION packets is given in Table 6.6/X.25.

TABLE 6.6/X.25

CODING OF RESTARTING CAUSE FIELD IN RESTART INDICATION PACKETS

	8	7	6	5	4	3	2	1
Local procedure error	0	0	0	0	0	0	0	1
Network congestion	0	0	0	0	0	0	1	1
Network operational	0	0	0	0	0	1	1	1

Diagnostic Code

Octet 5 is the Diagnostic Code and contains additional information on the reason for the restart.

In a RESTART REQUEST packet, the Diagnostic Code is not mandatory. The Diagnostic Code, if specified, is passed to the corresponding DTEs as the Diagnostic Code of a RESET INDICATION packet for permanent virtual circuits or a CLEAR INDICATION packet for virtual calls.

The coding of Diagnostic Code field in a RESTART INDICATION packet is given in Annex 5. The bits of the Diagnostic Code are all set to zero when no specific additional information for the restart is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

6.6.2 DTE and DCE Restart Confirmation Packets

Figure 6.15/X.25 illustrates the format of the DTE and DCE RESTART CONFIRMATION packets.

6.7 Diagnostic Packet

Figure 6.16/X.25 illustrates the format of the DIAGNOSTIC packet.

	Bits 8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				0	0	0	0
2	0	0	0	0	0	0	0	0
3	1	1	1	1	0	0	0	1
	Packet Type Identifier							
4	Diagnostic Code							
5	Diagnostic Explanation (See Note 2)							

Note 1: Coded 0001 (modulo 8) or 0010 (modulo 128)

Note 2: The figure is drawn assuming the Diagnostic Explanation field is an integral number of octets in length.

Figure 6.16/X.25 - Diagnostic packet format

Diagnostic Code Field

Octet 4 is the diagnostic code and contains information on the error condition which resulted in the transmission of the DIAGNOSTIC packet. The coding of the Diagnostic Code field is given in Annex 5.

Diagnostic Explanation Field

When the DIAGNOSTIC packet is issued as a result of the reception of an erroneous packet from the DTE (see Table A3.1/X.25), this field contains the first three octets of header information from the erroneous DTE packet. If the packet contains less than 3 octets, this field contains whatever bits were received.

When the DIAGNOSTIC packet is issued as a result of a DCE timeout (see Table A4.1/X.25), the Diagnostic Explanation field contains 2 octets coded as follows:

- Bits 8, 7, 6 and 5 of the first octet contains the General Format Identifier for the interface.

- Bits 4 to 1 of the first octet and bits 8 to 1 of the second octet are all 0 for expiration of time-out T10 and give the number of the logical channel on which the time-out occurred for expiration of time-out T12 or T13.

6.8 Packets Required for Optional User Facilities

6.8.1 DTE Reject (REJ) Packet For The Packet Retransmission Facility

Figure 6.17/X.25 illustrates the format of the DTE REJ packets, used in conjunction with the Packet Retransmission facility described in section 7.1.4.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.8.2 Call Set-up and Clearing Packets For The Fast Select Facility and Fast Select Acceptance Facility

6.8.2.1 Call Request and Incoming Call Packets

Figure 6.18/X.25 illustrates the format of CALL REQUEST and INCOMING CALL packets used in conjunction with the Fast Select facility and Fast Select Acceptance facility described in sections 7.2.4 and 7.2.5.

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier 0	0	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			Packet Type Identifier 0	1	0	0	1

(Modulo 8)

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier 0	0	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	1	0	0	1
4	P(R)							0

(When extended to modulo 128)

Figure 6.17/X.25 - **DTE REJ packet format**

	Bits 8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	1	0	1	1
4	Calling DTE address length				Called DTE address length			
	DTE Address (see Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Call User Data (See Notes 3 and 4)							

Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).
Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.
Note 3: Bits 8 and 7 of the first octet of the Call User Data field may have particular significance (see section 6.2.1).
Note 4: Maximum length of the Call User Data field is 128 octets.

Figure 6.18/X.25 - Call request and incoming call packet format for the Fast Select facility

Description of section 6.2.1 is applied to this section except the length of the Call User Data field has a maximum length of 128 octets.

Note: At present, some networks require the Call User Data field to contain an integral number of octets (see section 3, Note 2).

6.8.2.2 Call Accepted and Call Connected Packets

Figure 6.19/X.25 illustrates the format of CALL ACCEPTED and CALL CONNECTED packets used in conjunction with the Fast Select facility and Fast Select Acceptance facility described in sections 7.2.4 and 7.2.5.

Description of section 6.2.2 is applied to this section and, in addition, the Called User Data field may be present and has a maximum length of 128 octets. The Address Lengths field and Facility Length field are mandatory.

Note: At present, some networks require the Called User Data field to contain an integral number of octets (see section 3, Note 2).

If the Called User Data field is present, the use and format of this field is determined by bits 8 and 7 of the first octet of this field (see Note).

If bits 8 and 7 of the first octet of the Called User Data field are 00, a portion of the Called User Data field is used for protocol identification in accordance with other CCITT Recommendations.

If bits 8 and 7 of the first octet of the Called User Data field are 01, a portion of the Called User Data field may be used for protocol identification in accordance with specifications of Administrations.

If bits 8 and 7 of the first octet of the Called User Data field are 10, a portion of the Called User Data field may be used for protocol identification in accordance with specifications of International user bodies.

If bits 8 and 7 of the first octet of the Called User Data field are 11, no constraints are placed on the use by the DTE of the remainder of the Called User Data field.

Users are cautioned that if bits 8 and 7 of the first octet of the Called User Data field have any value other than 11, a protocol may be identified that is implemented within public data networks.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	0	1	1	1	1
4	Calling DTE address length				Called DTE address length			
	DTE Address (See Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Called User Data (See Notes 3 and 4)							

Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3: Bits 8 and 7 of the first octet of the Called User Data field may have particular significance (see section 6.8.2.2).

Note 4: Maximum length of the Called User Data field is 128 octets.

Figure 6.19/X.25 - Call accepted and call connected packet format for the Fast Select facility

Note: When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the Called User Data field, unless required to do otherwise by an appropriate request for an optional user facility on a per call basis. Such a facility is for further study.

6.8.2.3 Clear Request and Clear Indication Packets

Figure 6.20/X.25 illustrates the format of CLEAR REQUEST and CLEAR INDICATION packets used in conjunction with the Fast Select facility and Fast Select Acceptance facility described in sections 7.2.4 and 7.2.5.

Description of the Clearing Cause field and the Diagnostic Code field in section 6.2.3 is applied to this section. In addition the following fields may follow the Diagnostic Code field and in such cases the use of the Diagnostic Code field is mandatory.

Address Lengths Field

Octet 6 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE addresses in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Note: This field is coded with all 0s. Other codings are for further study.

Address Field

Note: Pending the further study indicated above, this field is not present.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

Note: This field is coded with all 0s. Other codings are for further study.

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	1	0	0	1	1
4	Clearing Cause							
5	Diagnostic Code							
6	Calling DTE address length				Called DTE address length			
	DTE Address (See Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Clear User Data (See Note 3)							

<u>Note 1</u>: Coded 0001 (modulo 8) or 0010 (modulo 128).
<u>Note 2</u>: The figure is drawn assuming a single address is present consisting of an odd number of digits.
<u>Note 3</u>: Maximum length of the Clear User Data field is 128 octets.

Figure 6.20/X.2[illegible] - Clear request and clear [illegible] packet format for the [illegible] facility

Facility Field

Note: Pending the further study indicated above, this field is not present.

Clear User Data Field

Following the Facility field, the Clear User Data field may be present and has a maximum length of 128 octets.

Note: At present, some networks require the Clear User Data field to contain an integral number of octets (see section 3, Note 2).

7. PROCEDURES AND FORMATS FOR OPTIONAL USER FACILITIES

7.1 Procedures for Optional User Facilities Associated with Virtual Circuit and Datagram Services

7.1.1 Extended Packet Sequence Numbering

Extended Packet Sequence Numbering is an optional user facility agreed for a period of time. It applies in common to all logical channels at the DTE/DCE interface.

This user facility, if subscribed to, provides sequence numbering of packets performed modulo 128. In the absence of this facility, the sequence numbering of packets is performed modulo 8.

7.1.2 Nonstandard Default Window Sizes

Nonstandard Default Window Sizes is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default window sizes from the list of window sizes supported by the Administration. Some networks may constrain the default window sizes to be the same for each direction of transmission across the DTE/DCE interface. In the absence of this facility, the default window sizes are 2.

Values other than the default window sizes may be negotiated for a virtual call by means of the Flow Control Parameter Negotiation facility (see section 7.2.2). Values other than the default window sizes may be agreed for a period of time for each permanent virtual circuit and each datagram logical channel.

7.1.3 Default Throughput Classes Assignment

Default Throughput Classes Assignment is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default throughput classes from the list of throughput classes supported by the Administration. Some networks may constrain the default throughput classes to be

the same for each direction of data transmission. In the absence of this facility, the default throughput classes correspond to the user class of service of the DTE (see section 7.4.2.6) but do not exceed the maximum throughput class supported by the network.

The default throughput classes are the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface. Values other than the default throughput classes may be negotiated for a virtual call by means of the Throughput Class Negotiation facility (see section 7.2.3). Values other than the default throughput classes may be agreed for a period of time for each permanent virtual circuit and each datagram logical channel.

7.1.4 Packet Retransmission

Packet Retransmission is an optional user facility agreed for a period of time. It applies in common to all logical channels at the DTE/DCE interface.

Note: In this section, the term "flow controlled packet" refers to the DCE DATA packet for virtual call and permanent virtual circuit logical channels and refers to the DCE DATAGRAM and DATAGRAM SERVICE SIGNAL packets for datagram logical channels.

This user facility, if subscribed to, allows a DTE to request retransmission of one or several consecutive flow controlled packets from the DCE by transferring across the DTE/DCE interface a DTE REJECT packet specifying a logical channel number and a sequence number P(R). The value of this P(R) should be within the range from the last P(R) received by the DCE up to, but not including, the P(S) of the next flow controlled packet to be transmitted by the DCE. If the P(R) is outside this range, the DCE will initiate the reset procedure with the cause "Local procedure error" and diagnostic #2.

When receiving a DTE REJECT packet, the DCE initiates on the specified logical channel retransmission of the flow controlled packets; the Packet Send Sequence Numbers of which are starting from P(R) where P(R) is indicated in the DTE REJECT packet. Until the DCE transfers across the DTE/DCE interface a flow controlled packet with a Packet Send Sequence Number equal to the P(R) indicated in the DTE REJECT packet, the DCE will consider the receipt of another DTE REJECT packet as a procedure error and reset the logical channel.

Additional flow controlled packets pending initial transmission may follow the retransmitted packet(s).

A DTE receive not ready situation indicated by the transmission of RNR packet is cleared by the transmission of a DTE REJECT packet.

The conditions under which the DCE ignores a DTE REJECT packet, or considers it as a procedure error, are those described for flow control packets (see Annex 3).

7.1.5 Incoming Calls Barred

Incoming Calls Barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls and datagrams.

This user facility, if subscribed to, prevents incoming virtual calls and datagrams from being presented to the DTE. The DTE may originate outgoing virtual calls and datagrams.

Note: Logical channels used for virtual calls retain their full duplex capability. Logical channels used for datagrams and datagram service signals retain their capability to convey datagram service signals.

7.1.6 Outgoing Calls Barred

Outgoing Calls Barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls and datagrams.

This user facility, if subscribed to, prevents the DCE from accepting outgoing virtual calls and datagrams from the DTE. The DTE may receive incoming virtual calls and datagrams.

Note: Logical channels used for virtual calls retain their full duplex capability.

7.1.7 One-way Logical Channel Outgoing

One-way Logical Channel Outgoing is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to *originating* outgoing virtual calls or datagrams only.

Note: A logical channel used for virtual calls retains its full duplex capability. A logical channel used for datagrams and datagram service signals retains its capability to convey datagram service signals.

The rules according to which Logical Channel Group Numbers and Logical Channel Numbers can be assigned to one-way outgoing logical channels for virtual calls are given in Annex 1.

Note: If all the logical channels for virtual calls and datagrams are one-way outgoing at a DTE/DCE interface, the effect is equivalent to the Incoming Calls Barred facility (see section 7.1.5).

7.1.8 One-way Logical Channel Incoming

One-way Logical Channel Incoming is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to receiving incoming virtual calls or datagrams only.

Note: A logical channel used for virtual calls retains its full duplex capability.

The rules according to which Logical Channel Group Numbers and Logical Channel Numbers can be assigned to one-way incoming logical channels for virtual calls are given in Annex 1.

Note: If all the logical channels for virtual calls and datagrams are one-way incoming at a DTE/DCE interface, the effect is equivalent to the Outgoing Calls Barred facility (see section 7.1.6).

7.1.9 Closed User Group

Closed User Group is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more closed user groups. A closed user group permits the DTEs belonging to the group to communicate with each other, but precludes communication with all other DTEs.

The calling/source DTE should specify the closed user group selected for a virtual call or datagram using the optional user facility parameters (see section 7.4.2.1) in the CALL REQUEST or DTE DATAGRAM packet.

The closed user group selected for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters (see section 7.4.2.1) in the INCOMING CALL or DCE DATAGRAM packet.

When a DTE only belongs to one closed user group or when the virtual call or datagram is associated with the DTE's preferential closed user group, this indication may not be present in the CALL REQUEST, INCOMING CALL, DTE DATAGRAM or DCE DATAGRAM packet.

7.1.10 Closed User Group with Outgoing Access

Closed User Group with Outgoing Access is an optional user facility agreed for a period of time for virtual calls or datagrams. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in section 7.1.9) and to originate virtual calls or datagrams to DTEs in the open part of the network and to DTEs having the incoming access capability.

The procedures for using this facility are the same as those given in section 7.1.9. However, the optional user facility parameters may not be present when originating virtual calls or datagrams to DTEs in the open part of the network or to DTEs having the incoming access capability.

7.1.11 Closed User Group with Incoming Access

Closed User Group with Incoming Access is an optional user facility agreed for a period of time for virtual calls or datagrams. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in section 7.1.9) and to receive incoming calls or datagrams from DTEs in the open part of the network and from DTEs having the outgoing access capability.

The procedures for using this facility are the same as those given in section 7.1.9. However, the optional user facility parameters may not be present when receiving incoming calls or datagrams from DTEs in the open part of the network or from DTEs having the outgoing access capability.

7.1.12 Incoming Calls Barred within a Closed User Group

Incoming Calls Barred within a Closed User Group is an optional user facility agreed for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to originate virtual calls or datagrams to DTEs in this closed user group, but precludes the reception of incoming calls or datagrams from other DTEs in this closed user group.

The procedures for using this facility are the same as those given in sections 7.1.9, 7.1.10 and 7.1.11.

7.1.13 Outgoing Calls Barred within a Closed User Group

Outgoing Calls Barred within a Closed User Group is an optional user facility agreed for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to receive virtual calls or datagrams from other DTEs in this closed user group, but prevents the DTE from originating virtual calls or datagrams to other DTEs in this closed user group.

The procedures for using this facility are the same as those given in sections 7.1.9, 7.1.10 and 7.1.11.

7.1.14 Bilateral Closed User Group

Bilateral Closed User Group is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more bilateral closed user groups. A bilateral closed user group permits a pair of DTEs who bilaterally agree to communicate with each other to do so, but precludes communication with all other

DTEs.

The calling/source DTE should specify the bilateral closed user group selected for a virtual call or datagram using the optional user facility parameters (see section 7.4.2.2) in the CALL REQUEST or DTE DATAGRAM packet. The called/destination DTE address length shall be coded all zeros.

The bilateral closed user group for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters in the INCOMING CALL or DCE DATAGRAM packet.

7.1.15 Bilateral Closed User Group with Outgoing Access

Bilateral Closed User Group with Outgoing Access is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more bilateral closed user groups (as in section 7.1.14) and to originate virtual calls or datagrams to DTEs in the open part of the network.

The procedures for using this facility are the same as those given in section 7.1.14.

7.1.16 Reverse Charging

Reverse Charging is an optional user facility which can be requested by a DTE for a given virtual call or for a datagram (see section 7.4.2.3).

7.1.17 Reverse Charging Acceptance

Reverse Charging Acceptance is an optional user facility agreed for a period of time.

This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls or datagrams which request the Reverse Charging facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls or datagrams which request the Reverse Charging facility.

7.1.18 RPOA Selection

RPOA Selection is an optional user facility which may be requested by a DTE for a given virtual call or for a datagram.

This user facility, when requested, provides for the user specification by the calling/source DTE of a particular RPOA transit network through which the call or datagram is to be routed internationally, when more than one RPOA transit network exists at an international gateway (see section 7.4.2.4).

7.2 Procedures for Optional User Facilities Only Available with Virtual Circuit Services

7.2.1 Nonstandard Default Packet Sizes

Nonstandard Default Packet Sizes is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default packet sizes from the list of packet sizes supported by the Administration. Some networks may constrain the packet sizes to be the same for each direction of data transmission across the DTE/DCE interface. In the absence of this facility, the default packet sizes are 128 octets.

Note: In this section, the term "packet sizes" refers to the maximum User Data field lengths of DCE DATA and DTE DATA packets.

Values other than the default packet sizes may be negotiated for a virtual call by means of the Flow Control Parameter Negotiation facility (see section 7.2.2). Values other than the default packet sizes may be agreed for a period of time for each permanent virtual circuit.

7.2.2 Flow Control Parameter Negotiation

Flow Control Parameter Negotiation is an optional user facility agreed for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation on a per call basis of the flow control parameters. The flow control parameters considered are the packet and window sizes at the DTE/DCE interface for each direction of data transmission.

Note: In this section, the term "packet sizes" refers to the maximum User Data field lengths of DCE DATA and DTE DATA packets.

In the absence of the Flow Control Parameter Negotiation facility, the flow control parameters to be used at a particular DTE/DCE interface are the default packet sizes (see section 7.2.1) and the default window sizes (see section 7.1.2).

When the calling DTE has subscribed to the Flow Control Parameter Negotiation facility, it may separately request packet sizes and window sizes for each direction of data transmission (see section 7.4.2.5). If a particular window size is not explicitly requested in a CALL REQUEST packet, the DCE will assume that the default window size was requested. If a particular packet size is not explicitly requested, the DCE will assume that the default packet size was requested.

When a called DTE has subscribed to the Flow Control Parameter Negotiation fa~ility, each INCOMING CALL packet will indicate the

packet and window sizes from which DTE negotiation can start. No relationship needs to exist between the packet and window sizes requested in the CALL REQUEST packet and those indicated in the INCOMING CALL packet. The called DTE may request window and packet sizes with facilities in the CALL ACCEPTED packet. The only valid facility requests in the CALL ACCEPTED packet, as a function of the facility indications in the INCOMING CALL packet, are given in Table 7.1/X.25. If the facility request is not made in the CALL ACCEPTED packet, the DTE is assumed to have accepted the indicated values (regardless of the default values).

TABLE 7.1/X.25

VALID FACILITY REQUESTS IN CALL ACCEPTED PACKET IN RESPONSE TO FACILITY INDICATIONS IN INCOMING CALL PACKET

Facility Indication	Valid Facility Request
W(indicated) $\geq$ 2	W(indicated) $\geq$ W(requested) $\geq$ 2
W(indicated) = 1	W(requested) = 1 or 2
P(indicated) $\geq$ 128	P(indicated) $\geq$ P(requested) $\geq$ 128
P(indicated) < 128	128 $\geq$ P(requested) $\geq$ P(indicated)

When the calling DTE has subscribed to the Flow Control Parameter Negotiation facility, every CALL CONNECTED packet will indicate the packet and window sizes to be used at the DTE/DCE interface for the call. The only valid facility indications in the CALL CONNECTED packet, as a function of the facility requests in the CALL REQUEST packet, are given in Table 7.2/X.25.

TABLE 7.2/X.25

VALID FACILITY INDICATIONS IN CALL CONNECTED PACKET IN RESPONSE TO FACILITY REQUESTS IN CALL REQUEST PACKET

Facility Request	Valid Facility Indication
W(requested) $\geq$ 2	W(requested) $\geq$ W(indicated) $\geq$ 2
W(requested) = 1	W(indicated) = 1 or 2
P(requested) $\geq$ 128	P(requested) $\geq$ P(indicated) $\geq$ 128
P(requested) < 128	128 $\geq$ P(indicated) $\geq$ P(requested)

The network may have constraints requiring the flow control parameters used for a call to be modified before indicating them to the DTE in the INCOMING CALL packet or CALL CONNECTED packet; e.g., the ranges of parameter values available on various networks may differ.

Window and packet sizes need not be the same at each end of a virtual call.

The role of the DCE in negotiating the flow control parameters may be network dependent.

7.2.3 Throughput Class Negotiation

Throughput Class Negotiation is an optional user facility agreed for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation on a per call basis of the throughput classes. The throughput classes are considered independently for each direction of data transmission.

Default values are agreed between the DTE and the Administration (see section 7.1.3). The default values correspond to the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface.

When the calling DTE has subscribed to the Throughput Class Negotiation facility, it may separately request the throughput classes of the virtual call in the CALL REQUEST packet (see section 7.4.2.6). If particular throughput classes are not requested, the DCE will assume the default values.

When a called DTE has subscribed to the Throughput Class Negotiation facility, each INCOMING CALL packet will indicate the

throughput classes from which DTE negotiation may start. These throughput classes are lower or equal to the ones selected at the calling DTE/DCE interface, either explicitly, or by default if the calling DTE has not subscribed to the Throughput Class Negotiation facility or has not explicitly requested throughput class values in the CALL REQUEST packet. These throughput classes indicated to the called DTE will also not be higher than the default throughput classes, respectively for each direction of transmission, at the calling and the called DTE/DCE interfaces. They may be further constrained by internal limitations of the network.

The called DTE may request with a facility in the CALL ACCEPTED packet the throughput classes that should finally apply to the virtual call. The only valid throughput classes in the CALL ACCEPTED packet are lower than or equal to the ones (respectively) indicated in the INCOMING CALL packet. If the called DTE does not make any throughput class facility request in the CALL ACCEPTED packet, the throughput classes finally applying to the virtual call will be the ones indicated in the INCOMING CALL packet.

If the called DTE has not subscribed to the Throughput Class Negotiation facility, the throughput classes finally applying to the virtual call are less than or equal to the ones selected at the calling DTE/DCE interface, and less than or equal to the default values defined at the called DTE/DCE interface.

When the calling DTE has subscribed to the Throughput Class Negotiation facility, every CALL CONNECTED packet will indicate the throughput classes finally applying to the virtual call.

When neither the calling DTE nor the called DTE has subscribed to the Throughput Class Negotiation facility, the throughput classes applying to the virtual call will not be higher than the ones agreed as defaults at the calling and called DTE/DCE interfaces. They may be further constrained to lower values by the network, e.g., for international service.

Note 1: Since both Throughput Class Negotiation and Flow Control Parameter Negotiation (see section 7.2.2) facilities can be applied to a single call, the achievable throughput will depend on how users manipulate the D bit.

Note 2: Users are cautioned that the choice of too small a window and packet size of a DTE/DCE interface (made by use of the Flow Control Parameter Negotiation facility) may adversely affect the attainable throughput class of a virtual call. This is likewise true of flow control mechanisms adopted by the DTE to control data transmission from the DCE.

7.2.4 Fast Select

Fast Select is an optional user facility which may be requested by a DTE for a given virtual call.

DTEs can request the Fast Select facility on a per call basis by means of an appropriate facility request (see section 7.4.2.7) in a CALL REQUEST packet using any logical channel which has been assigned to virtual calls.

The Fast Select facility, if requested in the CALL REQUEST packet and if it indicates no restriction on response, allows this packet to contain a Call User Data field of up to 128 octets and authorizes the DCE to transmit to the DTE, during the DTE waiting state, a CALL CONNECTED packet with a Called User Data field of up to 128 octets or a CLEAR INDICATION packet with a Clear User Data field of up to 128 octets.

The Fast Select facility, if requested in the CALL REQUEST packet and if it indicates restriction on response, allows this packet to contain a Call User Data field of up to 128 octets and authorizes the DCE to transmit to the DTE, during the DTE waiting state, a CLEAR INDICATION packet with a Clear User Data field of up to 128 octets; the DCE would not be authorized to transmit a CALL CONNECTED packet.

Where a DTE requests the Fast Select facility in a CALL REQUEST packet, the INCOMING CALL packet should be only delivered to the called DTE if that DTE has subscribed to the Fast Select Acceptance facility (see section 7.2.5).

If the called DTE has subscribed to the Fast Select Acceptance facility, it will be advised that the Fast Select facility, and an indication of whether or not there is a restriction on the response, has been requested through the inclusion of the appropriate facility in the INCOMING CALL packet.

If the called DTE has not subscribed to the Fast Select Acceptance facility, an INCOMING CALL packet with the Fast Select facility requested will not be transmitted and a CLEAR INDICATION packet with the cause "Fast select acceptance not subscribed" will be returned to the calling DTE.

The presence of the Fast Select facility indicating no restriction on response in an INCOMING CALL packet permits the DTE to issue as a direct response to this packet a CALL ACCEPTED packet with a Called User Data field of up to 128 octets or a CLEAR REQUEST packet with a Clear User Data field of up to 128 octets.

The presence of the Fast Select facility indicating restriction on response in an INCOMING CALL packet permits the DTE to issue as a direct response to this packet a CLEAR REQUEST packet with a Clear User Data field of up to 128 octets; the DTE would not be

authorized to send a CALL ACCEPTED packet.

The possibility to send a CLEAR REQUEST packet with a Clear User Data field up to 128 octets at any time instead of just in the DCE WAITING state (p3) is for further study.

Note: The Call User Data field, the Called User Data field and the Clear User Data field will not be fragmented for delivery across the DTE/DCE interface.

The significance of the CALL CONNECTED packet and the CLEAR INDICATION packet with the cause "DTE originated" as a direct response to the CALL REQUEST packet with the Fast Select facility is that the CALL REQUEST packet with the data field has been received by the called DTE.

All other procedures of a call in which the Fast Select facility has been requested are the same as those of a virtual call.

7.2.5 Fast Select Acceptance

Fast Select Acceptance is an optional user facility agreed for a period of time. This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls which request the Fast Select facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls which request the Fast Select facility.

7.2.6 D Bit Modification

D Bit Modification is an optional user facility agreed for a period of time. This facility applies to all virtual calls and permanent virtual circuits at the DTE/DCE interface. This facility is only intended for use by those pre D bit DTEs which were designed for operation on Public Data Networks that support end-to-end P(R) significance. It allows these DTEs to continue to operate with end-to-end P(R) significance within a national network after the network supports the delivery confirmation (D bit) procedure.

This facility, when subscribed to, will for communications within the national network:

(a) change the value of the D bit from 0 to 1 in all CALL REQUEST, CALL ACCEPTED and DTE DATA packets received from the DTE, and

(b) set the D bit to 0 in all INCOMING CALL, CALL CONNECTED and DCE DATA packets transmitted to the DTE.

For international operation, conversion (b) above applies and conversion (a) above does not apply. Other conversion rules for international operation are for bilateral agreement between

Administrations.

7.3 Procedures for Optional User Facilities Only Available with Datagram Service

7.3.1 Abbreviated Address

Abbreviated Address an optional user facility agreed for a period of time. This facility permits encoding of addresses into shorter representations as agreed between the Administration and DTE. Initially this facility is restricted to a 1:1 mapping of single addresses, but 1:N mapping for multiple addresses is for further study.

7.3.2 Datagram Queue Length Selection

Datagram Queue Length Selection is an optional user facility agreed for a period of time for each datagram logical channel. This facility enables selection of the number of datagram and datagram service signal packets that will be stored in a queue by the destination DCE when the rate of arrival of packets at the destination DCE from other sources exceeds the rate of delivery of packets to the destination DTE.

7.3.3 Datagram Service Signal Logical Channel

Datagram Service Signal Logical Channel is an optional user facility agreed for a period of time. This facility provides a separate logical channel for the DTE to receive only datagram service signals. This enables the DTE to separately flow control datagram service signal packets from the datagram packets.

7.3.4 Datagram Non-delivery Indication

Datagram Non-delivery Indication is an optional user facility which may be agreed for a period of time or selected on a per-datagram basis (see section 7.4.2.8).

This user facility, when requested, provides for a non-delivery indication service signal generated by the network when a datagram cannot be delivered to the destination DTE.

7.3.5 Datagram Delivery Confirmation

Datagram Delivery Confirmation is an optional user facility which may be agreed for a period of time or selected on a per-datagram basis (see section 7.4.2.9).

This user facility, when requested, provides for a delivery confirmation service signal generated by the network after the datagram has been accepted by the destination DTE.

7.4 Formats for Optional User Facilities

7.4.1 General

The Facility field is present only when a DTE is using an optional user facility requiring some indication in the CALL REQUEST, INCOMING CALL, CALL ACCEPTED, CALL CONNECTED, CLEAR REQUEST, CLEAR INDICATION, DTE DATAGRAM or DCE DATAGRAM packet.

The Facility field contains one or more facility elements. The first octet of each facility element contains a facility code to indicate the facility or facilities requested.

Note: The action taken by the DCE when a facility code appears more than once is for further study.

The facility codes are divided into four classes, by making use of bits 8 and 7 of the facility code field, in order to specify facility parameters consisting of 1, 2, 3, or a variable number of octets. The general class coding of the facility code field is shown below.

bit	8	7	6	5	4	3	2	1	
CLASS A	0	0	X	X	X	X	X	X	for single octet parameter field
CLASS B	0	1	X	X	X	X	X	X	for double octet parameter field
CLASS C	1	0	X	X	X	X	X	X	for triple octet parameter field
CLASS D	1	1	X	X	X	X	X	X	for variable length parameter field

For class D the octet following the facility code indicates the length, in octets, of the facility parameter field. The facility parameter field length is binary coded and bit 1 is the low order bit of this indicator.

The formats for the four classes are shown below.

CLASS A

	8	7	6	5	4	3	2	1
0	0	0	X	X	X	X	X	X
1	Facility parameter field							

CLASS B

	8	7	6	5	4	3	2	1
0	0	1	X	X	X	X	X	X
1	Facility parameter							
2	field							

CLASS C

	8	7	6	5	4	3	2	1
0	1	0	X	X	X	X	X	X
1	Facility							
2	parameter							
3	field							

CLASS D

	8	7	6	5	4	3	2	1
0	1	1	X	X	X	X	X	X
1	Facility parameter field length							
2	Facility parameter field							

The facility code field is binary coded and, without extension, provides for a maximum of 64 facility codes for classes A, B and C and 63 facility codes for class D giving a total of 255 facility codes.

Facility code 11111111 is reserved for extension of the facility code. The octet following this octet indicates an extended facility code having the format A, B, C or D as defined above. Repetition of facility code 11111111 is permitted and thus additional extensions result.

The coding of the facility parameter field is dependent on the facility being requested.

A facility code may be assigned to identify a number of specific facilities, each having a bit in the parameter field indicating facility requested/facility not requested. In this situation, the parameter field is binary encoded with each bit position relating to a specific facility. A 0 indicates that the facility related to the particular bit is not requested and a 1 indicates that the facility related to the particular bit is requested. Parameter bit positions not assigned to a specific facility are set to zero. If none of the facilities represented by the facility code are requested for a virtual call or datagram, the facility code and its associated parameter field need not be present.

A Facility Marker, consisting of a single octet pair, is used to separate requests for X.25 facilities, as defined in this section, from requests for non-X.25 facilities that may also be offered by an Administration. The first octet is a facility code and is set to zero and the second octet is the facility parameter field.

The coding of the parameter field will be either all zeros or all ones depending on whether the facility requests following the marker refer to facilities offered by the calling/source or called/destination network, respectively. For intra-network virtual calls or datagrams, the parameter field should be all zeros.

Requests for non-X.25 facilities offered by the calling/source and called/destination networks may be simultaneously present within the facility field and in such cases two Facility Markers will be required with parameter fields coded as described above.

Within the facility field, requests for X.25 facilities will precede all requests for non-X.25 facilities and Facility Markers need only be included when requests for non-X.25 facilities are present.

7.4.2 Coding of Facility Field for Particular Facilities

7.4.2.1 Coding of Closed User Group Facility

The coding of the facility code field and the format of the facility parameter field for Closed User Group are the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Closed User Groups is:

bit:	8	7	6	5	4	3	2	1
code:	0	0	0	0	0	0	1	1

Facility Parameter Field

The index to the Closed User Group selected for the virtual call or datagram is in the form of two decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 being the low order bit of the first digit and bit 1 being the low order bit of the second digit.

Indexes to the same Closed User Group at different DTE/DCE interfaces may be different.

7.4.2.2 Coding of Bilaterial Closed User Group Facility

The coding of the facility code field and the format of the facility parameter field for Bilateral Closed User Group are the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Bilateral Closed User Group is:

bit: 8 7 6 5 4 3 2 1

code: 0 1 0 0 0 0 0 1

Facility Parameter Field

The index to the Bilateral Closed User Group selected for the virtual call or datagram is in the form of 4 decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit, and bit 1 of the second octet being the low order bit of the fourth digit.

Indexes to the same Bilateral Closed User Group at different DTE/DCE interfaces may be different.

7.4.2.3 Coding of Reverse Charging Facility

The coding of the facility code and parameter fields for Reverse Charging is the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM, and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Reverse Charging is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 0 0 1

Facility Parameter Field

The coding of the facility parameter field is:

bit 1 = 0 for Reverse Charging not requested

bit 1 = 1 for Reverse Charging requested

Note: Bits 6, 5, 4, 3 and 2 may be used for other facilities; if not, they are set to 0. Use of bits 8 and 7 are described in section 7.4.2.7.

7.4.2.4 Coding of RPOA Selection Facility

The coding of the facility code and parameter fields for RPOA Selection is the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for RPOA Selection is:

bit:	8	7	6	5	4	3	2	1
code:	0	1	0	0	0	1	0	0

Facility Parameter Field

The parameter field contains the Data Network Identification Code for the requested RPOA transit network, and is in the form of 4 decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit, and bit 1 of the second octet being the low order bit of the fourth digit.

7.4.2.5 Coding of the Flow Control Parameter Negotiation Facility

7.4.2.5.1 Coding for Packet Sizes

The coding of the facility code field and the format of the facility parameter field for packet sizes are the same in CALL REQUEST, INCOMING CALL, CALL ACCEPTED, and CALL CONNECTED packets.

Facility Code Field

The coding of the facility code field for packet sizes is:

bit:	8	7	6	5	4	3	2	1
code:	0	1	0	0	0	0	1	0

Facility Parameter Field

The packet size for the direction of transmission from the called DTE is indicated in bits 4, 3, 2, and 1 of the first octet. The packet size for the direction of transmission from the calling DTE is indicated in bits 4, 3, 2, and 1 of the second octet. Bits 5, 6, 7 and 8 of each octet must be zero.

The four bits indicating each packet size are binary coded and express the logarithm base 2 of the number of octets of the maximum packet size.

Networks may offer values from 4 to 10, corresponding to packet sizes of 16, 32, 64, 128, 256, 512, or 1024, or a subset of these values. All Administrations will provide a packet size of 128.

7.4.2.5.2 Coding for Window Sizes

The coding of the facility code field and the format of the facility parameter field for window sizes are the same in CALL REQUEST, INCOMING CALL, CALL ACCEPTED, and CALL CONNECTED packets.

Facility Code Field

The coding of the facility code field for window sizes is:

bit:	8	7	6	5	4	3	2	1
code:	0	1	0	0	0	0	1	1

Facility Parameter Field

The window size for the direction of transmission from the called DTE is indicated in bits 7 to 1 of the first octet. The window size for the direction of transmission from the calling DTE is indicated in bits 7 to 1 of the second octet. Bit 8 of each octet must be zero.

The bits indicating each window size are binary coded and express the size of the window. A value of zero is not allowed.

Window sizes of 8 to 127 are only valid for calls which employ extended numbering. The ranges of values allowed by a network for calls with normal numbering and extended numbering are network dependent. All Administrations will provide a window size of 2.

7.4.2.6 Coding of Throughput Class Negotiation Facility

The coding of the facility code field and the format of the facility parameter field for Throughput Class Negotiation are the same in CALL REQUEST, INCOMING CALL, CALL ACCEPTED and CALL CONNECTED packets.

Facility Code Field

The coding of the facility code field for Throughput Class Negotiation is:

bit:	8	7	6	5	4	3	2	1
code:	0	0	0	0	0	0	1	0

Facility Parameter Field

The throughput class for transmission from the calling DTE is indicated in bits 4, 3, 2 and 1. The throughput class for transmission from the called DTE is indicated in bits 8, 7, 6 and 5.

The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated below.

bit: 4 or bit: 8	3 7	2 6	1 5	Throughput class (bits per second)
0	0	0	0	Reserved
0	0	0	1	Reserved
0	0	1	0	Reserved
0	0	1	1	75
0	1	0	0	150
0	1	0	1	300
0	1	1	0	600
0	1	1	1	1,200
1	0	0	0	2,400
1	0	0	1	4,800
1	0	1	0	9,600
1	0	1	1	19,200
1	1	0	0	48,000
1	1	0	1	Reserved
1	1	1	0	Reserved
1	1	1	1	Reserved

7.4.2.7 Coding of Fast Select Facility

The coding of the facility code and parameter fields for Fast Select is the same in CALL REQUEST and INCOMING CALL packets.

Facility Code Field

The coding of the facility code field for Fast Select is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 0 0 1

Facility Parameter Field

The coding of the facility parameter field is:

bit 8 = 0 and bit 7 = 0 or 1 for Fast Select not requested

bit 8 = 1 and bit 7 = 0 for Fast Select requested with no restriction on response

bit 8 = 1 and bit 7 = 1 for Fast Select requested with restriction on response

Note: Bits 6, 5, 4, 3 and 2 may be used for other facilities; if not, they are set to 0. Use of bit 1 is described in section 7.4.2.3.

7.4.2.8 Coding of Datagram Non-delivery Indication Facility

The coding of the facility code and parameter fields is the same in the DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Datagram Non-delivery Indication is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 1 1 0

Facility Parameter Field

The coding of the facility parameter field is:

bit 2 = 0 for Datagram Non-delivery Indication not requested

bit 2 = 1 for Datagram Non-delivery Indication requested

Note: Bits 8, 7, 6, 5, 4, and 3 may be used for other facilities; if not, they are set to 0. Use of bit 1 is described in section 7.4.2.9.

7.4.2.9 Coding of Datagram Delivery Confirmation Facility

The coding of the facility code and parameter fields is the same in the DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Datagram Delivery Confirmation is:

bit:	8	7	6	5	4	3	2	1
code:	0	0	0	0	0	1	1	0

Facility Parameter Field

The coding of the facility parameter field is:

bit 1 = 0 for Datagram Delivery Confirmation not requested

bit 1 = 1 for Datagram Delivery Confirmation requested

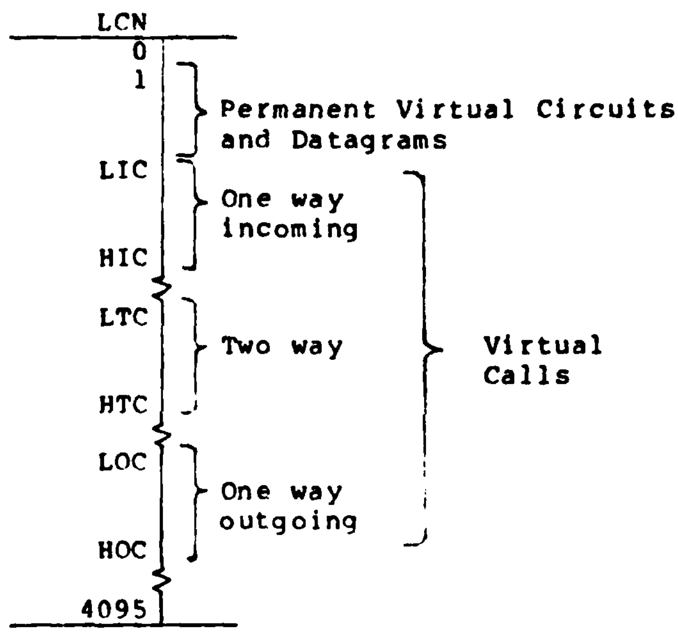
Note: Bits 8, 7, 6, 5, 4, and 3 may be used for other facilities; if not, they are set to 0. Use of bit 2 is described in section 7.4.2.8.

ANNEX 1
(to Recommendation X.25)

RANGE OF LOGICAL CHANNELS USED FOR VIRTUAL CALLS, PERMANENT VIRTUAL CIRCUITS AND DATAGRAMS

In the case of a single logical channel DTE, logical channel 1 will be used.

For each multiple logical channel DTE/DCE interface, a range of logical channels will be agreed upon with the Administration according to the following figure:



where:

Logical channels 1 to LIC-1: range of logical channels which may be assigned to permanent virtual circuits and datagrams.

Logical channels LIC to HIC: range of logical channels which are assigned to one-way incoming logical channels for virtual calls (see section 7.1.8).

Logical channels LTC to HTC: range of logical channels which are assigned to two-way logical channels for virtual calls.

Logical channels LOC to HOC: range of logical channels which are assigned to one-way outgoing logical channels for virtual calls (see section 7.1.7).

Logical channels HIC+1 to LTC-1, HTC+1 to LOC-1, and HOC+1 to 4095 are non-assigned logical channels.

Note 1: The reference to the numbers of logical channels is made according to a set of contiguous numbers from 0 (lowest) to 4095 (highest) using 12 bits made up of the 4 bits of the Logical Channel Group Number (see section 6.1.2) and the 8 bits of the Logical Channel Number (see section 6.1.3). The numbering is binary coded using bit positions 4 through 1 of octet 1 followed by bit positions 8 through 1 of octet 2 with bit 1 of octet 2 as the low order bit.

Note 2: All logical channel boundaries are agreed with the Administration for a period of time.

Note 3: In order to avoid frequent rearrangement of logical channels, not all logical channels within the range for permanent virtual circuits or datagrams are necessarily assigned.

Note 4: In the absence of permanent virtual circuits and datagram channels, logical channel 1 is available for LIC. In the absence of permanent virtual circuits, datagram channels and one-way incoming logical channels, logical channel 1 is available for LTC. In the absence of permanent virtual circuits, datagram channels, one way incoming logical channels and two-way logical channels, logical channel 1 is available for LOC.

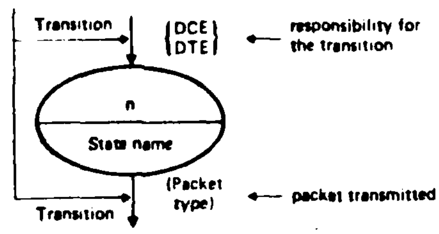
Note 5: DCE search algorithm for a logical channel for a new incoming call will be to use the lowest logical channel in the READY state in the range of LIC to HIC and LTC to HTC.

Note 6: In order to minimize the risk of call collision, the DTE search algorithm is suggested to start with the highest numbered logical channel in the READY state. The DTE could start with the two-way logical channel or one-way outgoing logical channel ranges.

ANNEX 2
(to Recommendation X.25)

PACKET LEVEL DTE/DCE INTERFACE STATE DIAGRAMS

Symbol definition of the state diagrams



Note 1: Each state is represented by an ellipse wherein the state name and number are indicated.

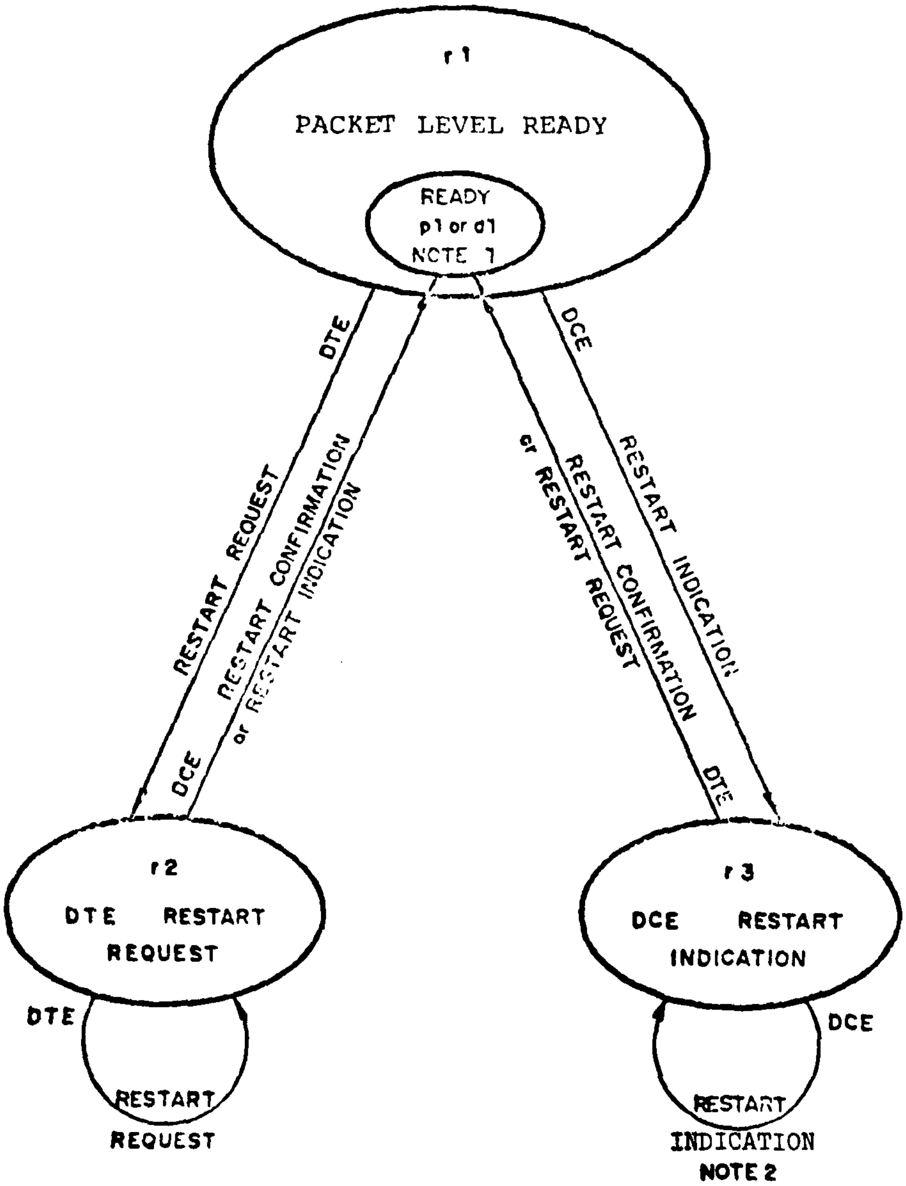
Note 2: Each state transition is represented by an arrow. The responsibility for the transition (DTE or DCE) and the packet that has been transferred are indicated beside that arrow.

Order definition of the state diagrams

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normal procedure fully it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This has been done by the following means:

- The figures are arranged in order of priority with Figure A2.1/X.25 (Restart) having the highest priority and subsequent figures having lower priority. Priority means that when a packet belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.

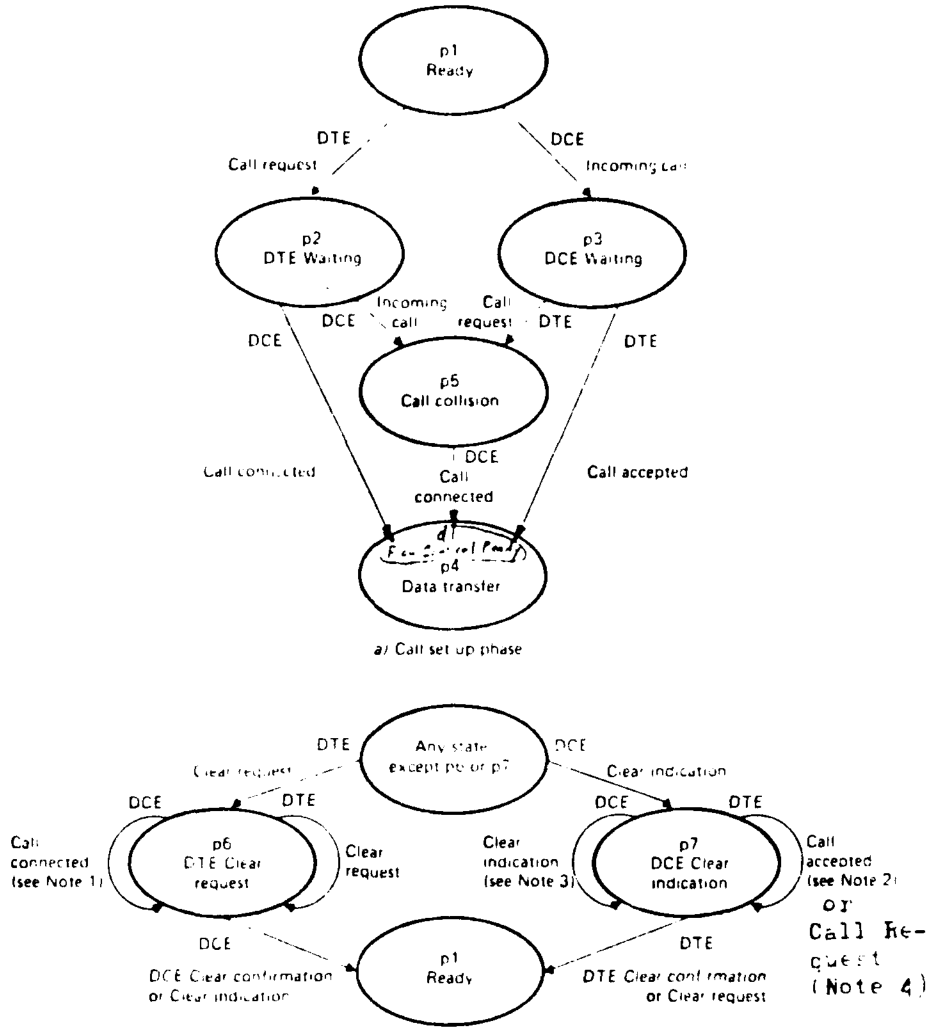
- The relation with a state in a lower order diagram is given by including that state inside an ellipse in the higher order diagram.



Note 1: State p1 for virtual calls or state d1 for permanent virtual circuits and datagram.

Note 2: This transition may take place after timeout T10.

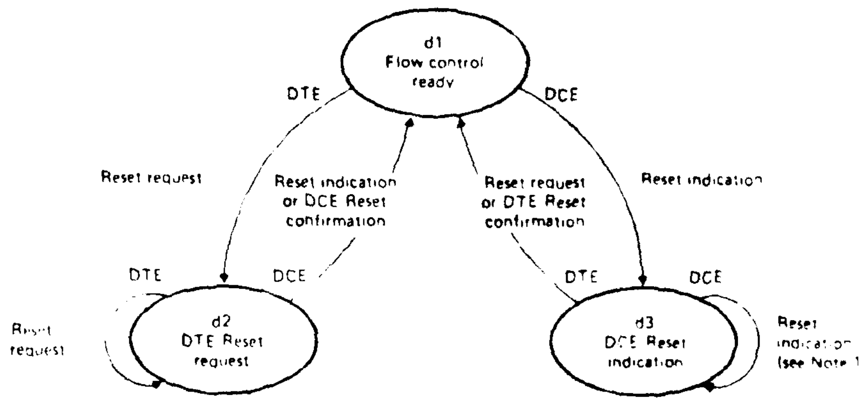
Figure A2.1/X.25 - Diagram of states for the transfer of restart packets.



b) Call clearing phase

Note 1 – This transition is possible only if the previous state was *DTE Waiting* (p2).
Note 2 – This transition is possible only if the previous state was *DCE Waiting* (p3).
Note 3 – This transition may take place after time-out T13.
Note 4 – This transition is possible only if the previous state was Ready (p1) or DCE Waiting (p3).

Figure A2.2/X.25 – Diagram of states for the transfer of call set-up and call clearing packets within the packet level ready (r1) state



Note 1 – This transition may take place after time-out T12

Figure A2.3/X.25 - Diagram of states for the transfer of reset packets within the data transfer (p4) state

ANNEX 3
(to Recommendation X.25)

ACTIONS TAKEN BY THE DCE ON RECEIPT OF PACKETS IN A GIVEN STATE OF THE PACKET LEVEL DTE/DCE INTERFACE AS PERCEIVED BY THE DCE

TABLE A3.1/X.25

Special cases

The number following the # is the diagnostic code (see Annex 5).

Packet from the DTE	Any state
Any packet with packet length <2 octets	DIAG #38
Any packet with incorrect general format identifier	DIAG #40
Any packet with unassigned logical channel	DIAG #36
Any packet with correct GFI and assigned logical channel	SEE TABLE A3.2/X.25

DIAG: The DCE discards the received packet and, for networks which implement the diagnostic packet, transmits a DIAGNOSTIC packet to the DTE containing the indicated diagnostic code.

There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is indicated in the DIAGNOSTIC packet. The order of packet de-coding and checking on networks is not standardized.

TABLE A3.2/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: restart procedure for assigned logical channels

The figures in brackets are the new states to be entered.
The figure following the # is the diagnostic code (Note 1).

Packet from the DTE with assigned logical channel \ State of the interface as perceived by the DCE	PACKET LEVEL READY r1	DTE RESTART REQUEST r2	DCE RESTART INDICATION r3
RESTART REQUEST	NORMAL (r2)	DISCARD (r2)	NORMAL (p1 or d1) Note 2
DTE RESTART CONFIRMATION	ERROR (r3) #17	ERROR (r3) #18	NORMAL (p1 or d1) Note 2
DATA, DATAGRAM, INTERRUPT, CALL SET-UP AND CLEARING, FLOW CONTROL OR RESET	SEE TABLE A3.3/X.25	ERROR (r3) #18	DISCARD (r3)
RESTART REQUEST OR DTE RESTART CONFIRMATION WITH BITS 1 TO 4 OF OCTET 1 OR BITS 1 TO 8 OF OCTET 2 ≠ 0	SEE TABLE A3.3/X.25	ERROR (r3) #41	DISCARD (r3)
PACKETS HAVING A PACKET TYPE IDENTIFIER WHICH IS SHORTER THAN 1 OCTET OR IS NOT SUPPORTED BY THE DCE	SEE TABLE A3.3/X.25	ERROR (r3) #38 #33	DISCARD (r3)

NOTES TO TABLE A3.2/X.25

NORMAL: The action taken by the DCE follows the procedures as defined in section 3. If a RESTART REQUEST packet or DTE RESTART CONFIRMATION packet received in state r3 exceeds the maximum permitted length, the DCE will invoke the ERROR procedure with diagnostic #39 and enter state r3. If a RESTART REQUEST packet received in state r1 exceeds the maximum permitted length, the action taken by the DCE is for further study.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a restarting by transmitting to the DTE a RESTART INDICATION packet, with the cause "Local procedure error" (diagnostic per Table A3.2/X.25). If connected through the virtual call, the distant DTE is also informed of the restarting by a CLEAR INDICATION packet, with the cause "Remote procedure error" (same diagnostic). In the case of a permanent virtual circuit, the distant DTE will be informed by a RESET INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

If a RESTART INDICATION is issued as a result of an error condition in state r2, the DCE should eventually consider the DTE/DCE interface to be in the PACKET LEVEL READY state (r1).

Note 1: There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet de-coding and checking on networks is not standardized.

Note 2: p1 for logical channels assigned to virtual calls; d1 for logical channels assigned to permanent virtual circuits and datagrams.

TABLE A3.3/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: call setup and clearing on assigned logical channels

The figures in brackets are the new states to be entered. The figure following the # is the diagnostic code (Note 1).

State of the interface as perceived by the DCE / Packet from the DTE with assigned logical channel	PACKET LEVEL READY r1						
	READY p1	DTE WAITING p2 Note 3	DCE WAITING p3 Note 2	DATA TRANSFER p4	CALL COLLISION p5 Notes 2,3	DTE CLEAR REQUEST p6	DCE CLEAR INDICATION p7
CALL REQUEST	NORMAL (p2) Note 4	ERROR (p7) #21	NORMAL (p5) Note 4	ERROR (p7) Note 5 #23	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
CALL ACCEPTED	ERROR (p7) #20	ERROR (p7) #21	NORMAL (p4) Note 6 ERROR (p7) Note 7 #42	ERROR (p7) Note 5 #23	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
CLEAR REQUEST	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6) Note 5	NORMAL (p6)	DISCARD (p6)	NORMAL (p1)
DTE CLEAR CONFIRMATION	ERROR (p7) #20	ERROR (p7) #21	ERROR (p7) #22	ERROR (p7) Note 5 #23	ERROR (p7) #24	ERROR (p7) #25	NORMAL (p1)
DATA, DATAGRAM, INTERRUPT, RESET OR FLOW CONTROL	ERROR (p7) #20	ERROR (p7) #21	ERROR (p7) #22	SEE TABLE A3.4/X.25	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
RESTART REQUEST OR DTE RESTART CONFIRMATION WITH BITS 1 TO 4 OF OCTET 1 OR BITS 1 TO 8 OF OCTET 2 ≠ 0	ERROR (p7) #41	ERROR (p7) #41	ERROR (p7) #41	SEE TABLE A3.4/X.25	ERROR (p7) #41	ERROR (p7) #41	DISCARD (p7)
PACKETS HAVING A PACKET TYPE IDENTIFIER WHICH IS SHORTER THAN ONE OCTET OR IS NOT SUPPORTED BY THE DCE	ERROR (p7) #38 #33	ERROR (p7) #38 #33	ERROR (p7) #38 #33	SEE TABLE A3.4/X.25	ERROR (p7) #38 #33	ERROR (p7) #38 #33	DISCARD (p7)

NOTES TO TABLE A3.3/X.25

NORMAL: The action taken by the DCE follows the procedures as defined in section 4. If the packet exceeds the maximum permitted length the DCE will invoke the ERROR procedure with diagnostic #39 and enter state p7.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a clearing by transmitting to the DTE a CLEAR INDICATION packet, with the cause "Local procedure error" (diagnostic per Table A3.3/X.25). If connected through the virtual call, the distant DTE is also informed of the clearing by a CLEAR INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

It is required that in the absence of an appropriate DTE response to a CLEAR INDICATION packet issued as a result of an error condition in state p6, the DCE should eventually consider the DTE/DCE interface to be in the READY state (p1).

Note 1: There may be more than one error associated with a packet (e.g., packet too long and transmitted in a wrong state). The network will stop processing of the packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet de-coding and checking on networks is not standardized.

Note 2: This state does not exist in the case of an outgoing one-way logical channel (as perceived by the DTE).

Note 3: This state does not exist in the case of an incoming one-way logical channel (as perceived by the DTE).

Note 4: (a) In the case of an incoming one-way logical channel (as perceived by the DTE) the DCE will transmit a CLEAR INDICATION with the cause "Local procedure error" and diagnostic #34.

(b) The DCE will transmit a CLEAR INDICATION if the CALL REQUEST contains an improper address format or facility field; call progress signals and diagnostic codes are listed below:

	Error Condition	Cause			Possible Diagnostics
1.	Address contains a non BCD digit	Local	Procedure	Error	#67,68
2.	Prefix digit not supported	"	"	"	"
3.	National address smaller than national address format permits	"	"	"	"
4.	National address larger than national address format permits	"	"	"	"
5.	DNIC less than four digits	"	"	"	"
6.	Facility length larger than 63	"	"	"	#64
7.	No combination of facilities could equal facility length	"	"	"	#64
8.	Facility length larger than remainder of packet	"	"	"	#38
9.	Facility values conflict (e.g., a particular combination not supported)	"	"	"	#66
10.	Facility code not allowed	Invalid	Facility	Request	#65
11.	Facility value not allowed	"	"	"	#66

(c) The DCE will transmit a CLEAR INDICATION if the remote DTE makes a procedure error, either for one of the above reasons associated with its call acceptance, or because of an expired timeout (diagnostic #49).

Note 5: In the case of an permanent virtual circuit, the DCE discards the received packet and indicates a reset by transmitting to the DTE a RESET INDICATION packet, with the cause "Local procedure error" (diagnostic #35). The distant DTE is also informed of the reset by a RESET INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

In the case of a datagram logical channel, the DCE discards the received packet and indicates a reset by transmitting to the DTE a RESET INDICATION packet, with the cause "Local procedure error".

Note 6: The ERROR procedure will be invoked by the DCE if the CALL ACCEPTED packet contains an improper address format or facility field. Examples are similar to those in Note 4 point (b) above.

Note 7: The presence of the Fast Select facility, indicating restriction on response in an INCOMING CALL packet prohibits the DTE from sending a CALL ACCEPTED packet.

TABLE A3.4/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: data transfer (flow control and reset) on assigned logical channels

The figures in brackets are the new states to be entered. The figure following the # is the diagnostic code (Note 1).

State of the interface as perceived by the DCE / Packet from the DTE with assigned logical channel	DATA TRANSFER p_4		
	FLOW CONTROL READY d1	DTE RESET REQUEST d2	DCE RESET INDICATION d3
RESET REQUEST	NORMAL (d2)	DISCARD (d2)	NORMAL (d1)
DTE RESET CONFIRMATION	ERROR (d3) #27	ERROR (d3) #28	NORMAL (d1)
DATA, DATAGRAM, INTERRUPT OR FLOW CONTROL	NORMAL (d1) Note 2	ERROR (d3) #28	DISCARD (d3)
RESTART REQUEST OR DTE RESTART CONFIRMATION WITH BITS 1 TO 4 OF OCTET 1 OR BITS 1 TO 8 OF OCTET 2 ≠ 0	ERROR (d3) #41	ERROR (d3) #41	DISCARD (d3)
PACKETS HAVING A PACKET TYPE IDENTIFIER WHICH IS SHORTER THAN ONE OCTET OR IS NOT SUPPORTED BY THE DCE	ERROR (d3) #27	ERROR (d3) #28	DISCARD (d3)
INVALID PACKET TYPE ON A PERMANENT VIRTUAL CIRCUIT	ERROR (d3) #35	ERROR (d3) #35	DISCARD (d3)
REJECT PACKET NOT SUBSCRIBED	ERROR (d3) #37	ERROR (d3) #37	DISCARD (d3)

NOTES TO TABLE A3.4/X.25

NORMAL: The action taken by the DCE follows the procedures as defined in sections 4 and 5. If the packet exceeds the maximum permitted length, the DCE will invoke the ERROR procedure using diagnostic code #39 and enter state d3.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a reset by transmitting to the DTE a RESET INDICATION packet, with the cause "Local procedure error" (diagnostic per Table A3.4/X.25). For virtual calls and permanent virtual circuits, the distant DTE is also informed of the reset by a RESET INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

If a RESET INDICATION is issued as a result of an error condition in state d2 for permanent virtual circuits and datagram logical channels, the DCE should eventually consider the DTE/DCE interface to be in the FLOW CONTROL READY state (d1) In this case, the action to be taken on a virtual call is for further study.

Note 1: There may be more than one error associated with a packet (e.g., Invalid P(S) and Invalid P(R)). The network will stop processing of the packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet de-coding and checking on networks is not standardized.

Note 2: The DCE will consider the receipt of a DTE INTERRUPT CONFIRMATION packet which does not correspond to a yet unconfirmed DCE INTERRUPT packet as an error and will reset the virtual call or permanent circuit (diagnostic #43). The DCE will either discard or consider as an error a DTE INTERRUPT packet received before a previous DTE INTERRUPT packet has been confirmed (diagnostic #44).

If the P(S) or P(R) received is not valid, the DCE will invoke the ERROR procedure with diagnostics #1 and #2 respectively, and enter state d3.

ANNEX 4
(to Recommendation X.25)

PACKET LEVEL DCE TIME-OUTS AND DTE TIME-LIMITS

DCE time-outs

Under certain circumstances this Recommendation requires the DTE to respond to a packet issued from the DCE within a stated maximum time.

Table A4.1/X.25 covers these circumstances and the actions that the DCE will initiate upon the expiration of that maximum time.

DTE time-limits

Under certain circumstances, this Recommendation requires the DCE to respond to a packet from the DTE within a stated maximum time. Table A4.2/X.25 gives these maximum times. The actual DCE response times should be well within the specified time-limits. The rare situation where a time-limit is exceeded should only occur when there is a fault condition.

To facilitate recovery from such fault conditions, the DTE may incorporate timers. The time-limits given in Table A4.2/X.25 are the lower limits of the times a DTE should allow for proper operation. A time-limit longer than the values shown may be used. Suggestions on possible DTE actions upon expiration of the time-limits are given in Table A4.2/X.25.

Note: A DTE may use a timer shorter than the value given for T21 in Table A4.2/X.25. This may be appropriate when the DTE knows the normal response time of the called DTE to an incoming call. In this case, the timer should account for the normal maximum response time of the called DTE and the estimated maximum call set-up time.

TABLE A4.1/X.25

DCE TIME-OUTS

Time-out number	Time-out value	State of the logical channel	Started when	Normally terminated when	Actions to be taken when the time-out expires (see Note 1) Local side	Remote side
T10	60 s	r3	DCE issues a restart indication	DCE leaves the r3 state (i.e., the restart confirmation or restart request is received)	DCE remains in r3 and may issue a Diagnostic packet (Note 2)	For permanent virtual circuits, DCE enters the d3 state signaling a reset indication (remote procedure error)
T11	180 s	p3	DCE issues an incoming call	DCE leaves the p3 state (e.g., the call accepted, clear request or call request is received)	DCE enters the p7 state signaling a clear indication (local procedure error)	DCE enters the p7 state signaling a clear indication (remote procedure error)
T12	60 s	d3	DCE issues a reset indication	DCE leaves the d3 state (e.g., the reset confirmation or reset request is received)	For virtual calls, DCE enters the p7 state signaling a clear indication (local procedure error). For permanent virtual circuits and datagram logical channels, DCE remains in d3 and may issue a Diagnostic packet (Note 3)	For virtual calls, DCE enters the p7 state signaling a clear indication (remote procedure error). For permanent virtual circuits, DCE enters the d3 state signaling a reset indication (remote procedure error)
T13	60 s	p7	DCE issues a clear indication	DCE leaves the p7 state (e.g., the clear confirmation or clear request is received)	DCE remains in p7 and may issue a Diagnostic packet (Note 4)	

NOTES TO TABLE A4.1/X.25

Note 1: The following Notes 2, 3 and 4 describe alternative DCE actions on timer expiration. It is envisaged that all networks will eventually conform to Table A4.1/X.25, however for an interim period the following procedures may be used.

No values have yet been assigned to the time-out t and the maximum number of retries n applying to the following notes, however it should be noted that some Administrations may use the combination t-infinite, n-zero (i.e., no retries and no recovery action) or t-finite, n-zero (i.e., no retries with recovery action on timer expiration). The values of n and t will not necessarily be the same for the clear, reset and restart procedures.

Note 2: Alternatively, the DCE will retransmit the RESTART INDICATION at regular intervals of t until a DTE RESTART CONFIRMATION is received or a restart collision occurs or a period (n + 1)t elapses since the first transmission of the RESTART INDICATION. If the restart procedure is not completed within the time-out period, appropriate recovery action will be taken.

Note 3: Alternatively, the DCE will transmit the RESET INDICATION at regular intervals of t until a DTE RESET CONFIRMATION is received or a reset collision occurs or a period (n + 1)t elapses since the first transmission of the RESET INDICATION. If the reset procedure is not completed within the time-out period the DCE will either:

i) clear the virtual call with an indication of procedure error, or

ii) in the case of permanent virtual circuit forward a RESET INDICATION (remote procedure error) to the local DTE at regular intervals t until a DTE RESET CONFIRMATION is received or a reset collision occurs.

Note 4: Alternatively, the DCE will retransmit a CLEAR INDICATION at regular intervals of t until a DTE CLEAR CONFIRMATION is received or a clear collision occurs or a period (n + 1)t elapses since the first retransmission of the CLEAR INDICATION. If the clear procedure is not completed within the time-out period, appropriate recovery action will be initiated. The nature of the recovery action is for further study.

TABLE A4.2/X.25

DTE TIME-LIMITS

Time-out number	Time-limit value	State of the logical channel	Started when	Normally terminated when	Preferred action to be taken when time-limit expires
T20	180 s	r2	DTE issues a restart request	DTE leaves the r2 state (i.e., the restart confirmation or restart indication is received)	-To retransmit the restart request (Note 1)
T21	200 s	p2	DTE issues a call request	DTE leaves the p2 state (e.g., the call connected, clear indication or incoming call is received)	-To transmit a clear request
T22	180 s	d2	DTE issues a reset request	DTE leaves the d2 state (e.g., the reset confirmation or reset indication is received)	-For virtual calls, to retransmit the reset request or to transmit a clear request -For permanent virtual circuits and datagram logical channels, to retransmit the reset request (Note 2)
T23	180 s	p6	DTE issues a clear request	DTE leaves the p6 state (e.g., the clear confirmation or clear indication is received	-To retransmit the clear request (Note 2)

Note 1: After unsuccessful retries, recovery decisions should be taken at higher levels.
Note 2: After unsuccessful retries, the logical channel should be considered out-of-order. The restart procedure should only be invoked for recovery if reinitialization of all logical channels is acceptable.

ANNEX 5
(to Recommendation X.25)

CODING OF X.25 NETWORK GENERATED DIAGNOSTIC FIELDS IN CLEAR, RESET AND RESTART INDICATION AND DIAGNOSTIC PACKETS (Notes 1, 2 and 3)

Diagnostics	Bits 8	7	6	5	4	3	2	1	Decimal
No Additional Information	0	0	0	0	0	0	0	0	0
Invalid P(S)	0	0	0	0	0	0	0	1	1
Invalid P(R)	0	0	0	0	0	0	1	0	2
				•	•	•			
	0	0	0	0	1	1	1	1	15
Packet type invalid	0	0	0	1	0	0	0	0	16
for state r1	0	0	0	1	0	0	0	1	17
for state r2	0	0	0	1	0	0	1	0	18
for state r3	0	0	0	1	0	0	1	1	19
for state p1	0	0	0	1	0	1	0	0	20
for state p2	0	0	0	1	0	1	0	1	21
for state p3	0	0	0	1	0	1	1	0	22
for state p4	0	0	0	1	0	1	1	1	23
for state p5	0	0	0	1	1	0	0	0	24
for state p6	0	0	0	1	1	0	0	1	25
for state p7	0	0	0	1	1	0	1	0	26
for state d1	0	0	0	1	1	0	1	1	27
for state d2	0	0	0	1	1	1	0	0	28
for state d3	0	0	0	1	1	1	0	1	29
				•	•	•			
	0	0	0	1	1	1	1	1	31
Packet not allowed	0	0	1	0	0	0	0	0	32
unidentifiable packet	0	0	1	0	0	0	0	1	33
call on one way logical channel	0	0	1	0	0	0	1	0	34
invalid packet type on a permanent virtual circuit	0	0	1	0	0	0	1	1	35
packet on unassigned logical channel	0	0	1	0	0	1	0	0	36
REJECT not subscribed to	0	0	1	0	0	1	0	1	37
packet too short	0	0	1	0	0	1	1	0	38
packet too long	0	0	1	0	0	1	1	1	39
invalid general format identifier	0	0	1	0	1	0	0	0	40
restart with nonzero in bits 1-4,9-16	0	0	1	0	1	0	0	1	41
packet type not compatible with facility	0	0	1	0	1	0	1	0	42
unauthorized interrupt confirmation	0	0	1	0	1	0	1	1	43
unauthorized interrupt	0	0	1	0	1	1	0	0	44
				•	•	•			

	0	0	1	0	1	1	1	1	4
Timer expired	0	0	1	1	0	0	0	0	4
for INCOMING CALL	0	0	1	1	0	0	0	1	4
for CLEAR INDICATION	0	0	1	1	0	0	1	0	5
for RESET INDICATION	0	0	1	1	0	0	1	1	5
for RESTART INDICATION	0	0	1	1	0	1	0	0	5
				• • •					
	0	0	1	1	1	1	1	1	6
Call setup problem	0	1	0	0	0	0	0	0	6
facility code not allowed	0	1	0	0	0	0	0	1	6
facility parameter not allowed	0	1	0	0	0	0	1	0	6
invalid called address	0	1	0	0	0	0	1	1	6
invalid calling address	0	1	0	0	0	1	0	0	6
				• • •					
	0	1	0	0	1	1	1	1	7
Not assigned	0	1	0	1	0	0	0	0	8
				• • •					
	0	1	0	1	1	1	1	1	9
Not assigned	0	1	1	0	0	0	0	0	9
				• • •					
	0	1	1	0	1	1	1	1	11
Not assigned	0	1	1	1	0	0	0	0	11
				• • •					
	0	1	1	1	1	1	1	1	12
Reserved for network specific diagnostic information	1	0	0	0	0	0	0	0	12
				• • •					
	1	1	1	1	1	1	1	1	25

Note 1: Not all diagnostic codes need apply to a specific network, but those used are as coded in the table.

Note 2: A given diagnostic need not apply to all packet types (i.e., RESET INDICATION, CLEAR INDICATION, RESTART INDICATION and DIAGNOSTIC packets).

Note 3: The first diagnostic in each grouping is a generic diagnostic and can be used in place of the more specific diagnostics within the grouping. The decimal 0 diagnostic code can be used in situations where no additional information is available.

APPENDIX B

INTERIM FEDERAL STANDARD 1041

CALL PROGRESS SIGNALS FOR X.25

FROM CCITT RECOMMENDATION X.96 (1980)

APPENDIX B

Descriptions of Call Progress Signals (Cause Codes)

The call progress signals and the related circumstances giving rise to them are defined in Table 1.

The significance of categories indicates broadly the type of action expected of the DTE receiving the signal:

Category	
A	requested action confirmed by network.
B	call cleared because the procedure is complete.
C1 and C2	call cleared. The calling DTE should call again soon: the next attempt may be successful. However, after a number of unsuccessful call attempts with the same response the cause could be assumed to be in Category D1 or D2. The interval between successive attempts, and the maximum number of attempts, will depend on a number of circumstances including: - nature of the call progress signal - users' traffic pattern - tariffs - possible regulations by the network provider. or reset. The DTE may continue to transmit data recognizing that data loss may have occurred.

D1 and D2	call cleared. The calling DTE should take other action to clarify when the call attempt might be successful. or reset (for permanent virtual circuit and datagram logical channels only). The DTE should cease data transmission and take other action as appropriate.
C1 and D1	due to subscriber condition.
C2 and D2	due to network condition.

The sequence of call progress signals in the table implies, for Categories C and D, the order of call set-up processing by the network. In general the DTE can assume, on receiving a call progress signal, that no condition higher up the table is present. Network congestion is an exception to this general rule. The actual coding of call progress signals does not necessarily reflect this sequence.

Users and DTE manufacturers are warned to make due allowance to possible later extensions to this table by providing appropriate fall-back routines for unexpected signals.

For datagram service, which does not embrace the concept of a call, the term "call" should be interpreted as "datagram", "calling" as "source", "called" as "destination", "cleared" as "not delivered".

Table 1

Call Progress Signal	Definition	Category
Delivery confirmation	The datagram has been accepted by the destination DTE.	A
Local procedure error	A procedure error caused by the DTE is detected by the DCE at the local DTE/DCE interface.	C1
Network congestion	A condition exists in the network such as: 1) temporary network congestion 2) temporary fault condition within the network, including procedure error within a network or an international link.	C2
Invalid facility request	A facility requested by the calling DTE is detected as invalid by the DCE at the local DTE/DCE interface. Possible reasons include: - request for a facility which has not been subscribed to by the DTE; - request for a facility which is not available in the local network; - request for a facility which has not been recognized as valid by the local DCE.	D1 or D2
RPOA Out of Order	The RPOA nominated by the calling DTE is unable to forward the call.	D2
Not obtainable	The called DTE address is out of the numbering plan or not assigned to any DTE.	D1

Call Progress Signal	Definition	Category
Access barred	The calling DTE is not permitted the connection to the called DTE. Possible reasons include: - unauthorized access between the calling DTE and the called DTE; - incompatible closed user group.	D1
Reverse charging acceptance not subscribed	The called DTE has not subscribed to the reverse charging acceptance facility.	D1
Fast select acceptance not subscribed	The called DTE has not subscribed to the fast select acceptance facility.	D1
Incompatible destination	The remote DTE/DCE interface or the transit network does not support a function or facility requested (e.g., the datagram service).	D1
Out of order	The remote number is out of order. Possible reasons include: - DTE is Uncontrolled Not Ready; - DCE Power Off; - Network fault in the local loop; - X.25 Level 1 not functioning; - X.25 Level 2 not in operation.	D1 or D2
Number busy	The called DTE is detected by the DCE as engaged on other call(s), and therefore as not being able to accept the incoming call. (In the case of the datagram service, the queue at the destination DCE is full.)	C1

Call Progress Signal	Definition	Category
Remote procedure error	A procedure error caused by the remote DTE is detected by the DCE at the remote DTE/DCE interface.	D1
Network operational	Network is ready to resume normal operation after a temporary failure or congestion.	C1
Remote DTE operational	Remote DTE/DCE interface is ready to resume normal operation after a temporary failure or out of order condition (e.g., restart at the remote DTE/DCE interface). Loss of data may have occurred.	C1 or D1
DTE originated	The remote DTE has initiated a clear, reset or restart procedure.	B or D1

APPENDIX C

INTERIM FEDERAL STANDARD 1041

INTERNATIONAL USER SERVICES AND FACILITIES

FROM CCITT RECOMMENDATION X.2 (1980)

Facilities of packet switched data networks

User Facility	VC	PVC	DG
1. Optional user facilities assigned for an agreed contractual period			
1.1 Extended packet sequence numbering (modulo 128)	A	A	A
1.2 Non-standard default window sizes	A	A	A
1.3 Non-standard default packet sizes 16, 32, 64, 256, 512, 1024	A	A	-
1.4 Default throughput clear assignment	A	A	A
1.5 Flow control parameter negotiation	E	-	-
1.6 Throughput class negotiation	E	-	-
1.7 Packet re-transmission	A	A	A
1.8 Incoming calls barred	E	-	E
1.9 Outgoing calls barred	E	-	E
1.10 One-way logical channel outgoing	E	-	A
1.11 One-way logical channel incoming	A	-	A
1.12 Closed user group	E	-	E
1.13 Closed user group with outgoing access	A	-	A
1.14 Closed user group with incoming access	A	-	A
1.15 Incoming calls barred within a closed user group	A	-	A
1.16 Outgoing calls barred within a closed user group	A	-	A
1.17 Bilateral closed user group	A	-	A
1.18 Bilateral closed user group with outgoing access	A	-	A
1.19 Reverse charging acceptance	A	-	A
1.20 Fast select acceptance	A	-	-
1.21 Datagram queue length selection	-	-	A
1.22 Datagram service signal logical channel	-	-	A
1.23 Datagram non-delivery indication	-	-	E
1.24 Datagram delivery confirmation	-	-	E
1.25 Multiple circuits to the same DTE	A	A	A
1.26 Charging information	FS	-	FS
1.27 Direct call	FS	-	FS
1.28 Multiple terminals with the same data number	FS	-	FS
1.29 On-line facility registration	A	-	A
1.30 D-bit modification	A	A	-

2.	Optional user facilities requested by the DTE on a per call basis			
2.1	Closed user group selection	E	-	E
2.2	Bilateral closed user group selection	A	-	A
2.3	Reverse charging	A	-	A
2.4	RPOA selection	A	-	A
2.5	Flow control parameter negotiation	E	-	-
2.6	Fast select	A	-	-
2.7	Throughput class negotiation	E	-	-
2.8	Abbreviated address calling	FS	-	A
2.9	Datagram non-delivery indication	-	-	E
2.10	Datagram delivery confirmation	-	-	E
2.11	Multi-address calling	A	-	FS
2.12	Charging information	FS	-	FS

Legend for Table 1/X.2:

E = An essential user service or facility to be made available internationally.

A = An additional user service or facility which may be available in certain data networks and may also be available internationally.

FS = For further study.

\- = Not applicable.

DG = Applicable when the datagram services being used.

VC = Applicable when the virtual call service is being used.

PVC = Applicable when the permanent virtual circuit service is being used.

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